Rules and Regulations for the Classification of Naval Ships, January 2008

Notice No. 2

Effective Date of Latest Amendments:

See page 1

Issue date: September 2008

RULES AND REGULATIONS FOR THE CLASSIFICATION OF NAVAL SHIPS, *January 2008*

Notice No. 2

This Notice contains amendments within the following Sections of the *Rules and Regulations for the Classification of Naval Ships, January 2008.* The amendments are effective on the dates shown:

Volume	***Part***	***Chapter***	***Section***	***Effective date***
1	1	2	Introduction, 1, 3, 6	1 January 2009
1	1	2	3	Corrigenda
1	1	3	2	1 January 2009
1	3	3	2	1 January 2009
1	3	5	10	Corrigenda
1	4	1	7	1 January 2009
1	4	2	10	Corrigenda
1	5	2	2	Corrigenda
1	5	3	1	1 May 2008
1	5	3	3	Corrigenda
1	5	4	1	1 May 2008
1	6	4	4	Corrigenda
1	6	6	3, 4	1 August 2008
2	1	1	7	1 January 2009
2	1	2	6, 10, 13, 16	1 January 2009
2	1	3	1, 2, 3, 4, 5, 6, 7	1 January 2009
2	2	1	5, 9, 13, 14	1 January 2009
2	2	1	9, 10	Corrigenda
2	2	2	1	Corrigenda
2	2	2	4	1 January 2009
2	2	3	4	1 January 2009
2	3	2	4	1 January 2009
2	4	2	7	Corrigenda
2	4	3	7	Corrigenda
2	4	4	1, 2, 5, 6, 8	1 January 2009
2	5	1	2	1 January 2009
2	5	3	2	1 January 2009
2	5	4	1, 2	1 January 2009
2	7	1	5, 13, 16	1 January 2009
2	7	3	2	1 January 2009
2	8	1	1, 15	1 January 2009
2	8	2	1	1 January 2009
2	9	1	1	1 January 2009
2	9	1	1	Corrigenda
2	9	1	2, 6	1 January 2009
2	10	1	3, 5, 6, 7, 8, 10 11, 16, 20	1 January 2009
2	10	1	9, 14	Corrigenda
3	1	3	1, 2, 3, 4, 7	1 January 2009
3	1	4	1, 5, 6	1 January 2009
3	2	2	2	1 January 2009

It will be noted that the amendments also include corrigenda, which are effective from the date of this Notice.

The *Rules and Regulations for the Classification of Naval Ships, January 2008* are to be read in conjunction with this Notice No. 2. The status of the Rules is now:

Rules for Naval Ships	Effective date:	January 2008
Notice No. 1	Effective dates:	1 March 2008
Notice No. 2	Effective dates:	1 May 2008, 1 August 2008 1 January 2009 & Corrigenda

Volume 1, Part 1, Chapter 2
Classification Regulations

Effective date 1 January 2009

■ *Introduction*

Machinery Naval Class

Where agreed Naval Ship Classification will provide for the safety and reliability of propulsion, steering and other essential auxiliary engineering systems, including the arrangements for lifting appliances. When Machinery Naval Class is adopted, the aspects included in the ~~D~~definition of Hull Naval Class also apply.

■ *Section 1* Conditions for Classification

1.1 Framework of Classification

1.1.11 It is a requirement of classification that lifting appliance arrangements are to comply with and be maintained in compliance with specified standard(s). The specified standard(s) and on-going certification regime are to be notified to LR by the Naval Authority in writing. LR will provide advice on this aspect at the request of the Owner/Naval Authority, *see also* 3.9 for the **LAP** or **LA** notation.

1.2 Application

~~*1.2.2* Except in the case of a special directive by LR no new Rule or alteration in any existing Rule materially affecting Classification is to be applied compulsorily within six months of its adoption, nor after the approval of the original midship section or equivalent structural plans. Where it is desired to use existing previously approved plans for a new contract, written application is to be made to LR.~~

~~*1.2.3*~~ *1.2.2* At the discretion of LR, ship types which are specifically covered by LR's *Rules and Regulations for the Classification of Ships* or other LR's Rules and Regulations for Classification may be considered for classification in accordance with these Rules and Regulations. *See* 9.1.1.

■ *Section 3* Character of Classification and Class notations

3.7 Military Distinction notations

(Part only shown)

3.7.1 Military Distinction notations may be assigned if a particular feature relating to military loads has been incorporated in the design. The requirements for all the Military distinction notations are given in Part 4.

✠ MD This military distinction notation will be assigned when military aspects of the ship have been constructed under LR's Special Survey and in accordance with LR's Rules and Regulations. ~~In particular, the following confidential notations are available, and details will be known only to the Owner and LR.~~

~~**MD** This military distinction notation will be assigned when military aspects of the ship have been assessed in accordance with LR's Rules and Regulations. In particular, the following confidential notations are available, and will be known only to the Owner and LR.~~

$\overline{✠}$ MD This military distinction notation will be assigned when military aspects of the ship have been constructed under LR's Special Survey in accordance with plans approved by the Naval Authority in accordance with Rules and Regulations equivalent to those of LR.

MD This military distinction notation will be assigned when military aspects of the ship have been assessed by the Naval Authority in accordance with the Rules and Regulations equivalent to those of LR.

In particular, the following confidential notations are available, and will be known only to the Owner and LR.

Table 2.3.1 Hull, Military and Other Class Notations

Mandatory Notations		Other Notations		
Ship Type	Service Area	Hull Strength	Military Distinction ✠ MD	Others
See 3.4 (Select one:) **NS1** **NS2** **NS3** **NSA** Description of ship's role Examples: Cruiser Helicopter Carrier Aircraft Carrier Destroyer Frigate Corvette Amphibious Assault Ship Amphibious Transport Dock Landing Craft Minehunter Minelayer Mine-sweeper Patrol Ship Survey Ship e.g. NS1 Helicopter Carrier Oil Supply Ship Landing Ship Dock Survey Ship Stores Replenishment Ship Transport Dock Ro-Ro Ship Troop Carrier Vehicle Carrier Air Cushioned Support Vehicle Military Operations **AIR** Aircraft Operations **LA** Lifting Appliances	*See* 3.5 (Select one:) **SA1** Service Area 1 **SA2** Service Area 2 **SA3** Service Area 3 **SA4** Service Area 4 **SAR** Service Area Restricted	*See* 3.6 **IB1 IB2** **ESA1 ESA2** Extreme Strength Assessment **RSA1 RSA2 RSA3** Residual Strength Assessment **TLA** Total Load Assessment **SDA** Structural Design Assessment **FDA** Fatigue Design Assessment	*See* 3.7 Internal Air Blast **EB1 EB2 EB3 EB4** External Air Blast **SH1 SH2 SH3** Shock Enhancement **WH1 WH2 WH3** Whipping Assessment **FP1 FP2** Fragmentation Protection **SP** Small Arms Protection	*See* 3.9 ~~**LA LA(N)**~~ **LAP** Lifting Appliances **TA1 TA2 TA3 TA(S)** Towing Arrangements **SD** Special Duties **CM** Construction Monitoring **SEA (HSS-n)** Ship Event Analysis Hull Surveillance System **SEA (VDR)** Ship Event Analysis Voyage Data Recorder **SEA (VDR-n)** Sea Event Analysis Voyage Data Recorder (strain gauges) **ES** Enhanced Scantlings **SERS** Ship Emergency Response Service **EER** Escape, Emergency Access, Evacuation and Rescue (*see* Note) **FIRE** Fire Protection (*see* Note) **LSAE** Life Saving and Evacuation (*see* Note) **ESC** Escape and Emergency Access (*see* Note) **SNC** Safety of Navigation and Communication (*see* Note) **POL** Pollution Prevention **Ice Class** Navigation in Ice **LMA** Manoeuvring Assessment **CEPAC** Crew and Embarked Personnel Comfort **EP** Environmental Protection $\overline{\textbf{EP}}$ Environmental protection **LI** Approved Loading Instrument **HPMS** Hull Planned Maintenance Scheme
NOTE Star Endorsement (*) may be assigned to this notation where the arrangements on board are in accordance with stated National Administration requirements.				

Table 2.3.2 Machinery Class Notations

Machinery Notations
See 3.8

✠ LMC
Propulsion and essential machinery

$\overline{✠}$ LMC
Propulsion and essential machinery

[✠] LMC
Propulsion and essential machinery

LMC
Propulsion and essential machinery

MCH
Propulsion and essential machinery

SCM
Screwshaft Condition Monitoring

TCM
Turbine Condition Monitoring

PMR
Propulsion System Redundancy

PMR*
Propulsion System Redundancy in Separate Compartments

SMR
Steering System Redundancy

SMR*
Steering System Redundancy in Separate Compartments

PSMR
Propulsion and Steering System Redundancy

PSMR*
Propulsion and Steering System Redundancy in Separate Compartments

L
Additional character to **SMR**, **PMR**, **PSMR** and ***** notations for limited capability

ELS
~~Electrical power supplies to STANAG 1008~~
Quality of electrical power supplies

AG1
Enhanced analysis of propulsion and/or auxiliary gear elements

AG2
Enhanced three dimensional finite element analysis of propulsion and/or auxiliary gear elements

AP1
Enhanced assessment of propeller manufacturing tolerances on fast ships and craft

AP2
Enhanced assessment of propeller manufacturing tolerances having reduced noise characteristics

MPMS
Machinery Planned Maintenance Scheme

MCM
Machinery Planned Maintenance Scheme with Condition Monitoring

RCM
Machinery Planned Maintenance Scheme with Reliability Centred Maintenance

RAS(ABV)
Replenishment at Sea, Astern, Abeam and VERTREP

RAS(AB)
Replenishment at Sea, Abeam and Astern

RAS(AV)
Replenishment at Sea, Astern and VERTREP

RAS(BV)
Replenishment at Sea, Abeam and VERTREP

RAS(A)
Replenishment at Sea, Astern

RAS(B)
Replenishment at Sea, Abeam

RAS(V)
Replenishment at Sea, VERTREP

(NT)
Additional to **RAS( )**, NATO requirements

UMS
Unattended Machinery Spaces

CCS
Centralised Control Station

ICC
Integrated Computer Control

IP
Integrated Propulsion

DP(CM)
Dynamic Positioning
(Centralised Remote Manual Controls)

DP(AM)
Dynamic Positioning
(Automatic main and manual standby controls)

DP(AA)
Dynamic Positioning
(Automatic main and automatic standby controls)

DP(AAA)
Dynamic Positioning
(Automatic main and automatic standby controls with additional /emergency automatic control)

~~**NAV**~~
~~Navigation equipment~~

NAV1
Navigation equipment

IBS
Integrated Bridge System

PRM
Provision Refrigeration Machinery

3.8 Machinery and Engineering Systems notations

(Part only shown)

3.8.1 The following class notations are associated with the machinery construction and arrangement, and may be assigned:

SMR* This notation will be assigned where the steering systems for manoeuvring are arranged so that steering capability will continue to be available in the event of a single failure in the steering gear equipment or loss of power supply or control system ~~to~~ for any steering system and where the steering systems are installed in separate compartments such that, in the event of the loss of one compartment, steering capability will continue to be available. It also denotes that the installation has been arranged, installed and tested in accordance with LR's Rules.

PSMR* This notation will be assigned where the main propulsion and steering systems are configured such that, in the event of a single failure in equipment, the ship will retain not less than 50 per cent of the installed prime mover capacity and not less than 50 per cent of the installed propulsion systems and retain steering capability. The propulsion and steering arrangements are to be installed in separate compartments such that in the event of the loss of one compartment, the ship will retain availability of propulsion power and manoeuvring capability. It also denotes that the installation has been arranged, installed and tested in accordance with LR's Rules.

L This character will be added to the **PMR**, **SMR**, **PSMR** and ***** notations to indicate a limited capability.

ELS This notation will be assigned where both the quality and integrity of on board electrical power supplies meet the requirements of a relevant and acceptable Naval Standard, such as NATO Standardization Agreement (STANAG) 1008. It also denotes that the installation has been arranged, installed and tested in accordance with LR Rules.

(NT) This notation will be assigned in addition to a **RAS( )** notation where a vessel complies with NATO replenishment at sea requirements.

PRM This notation may be assigned when the provision refrigeration machinery and systems have been arranged, installed and tested in accordance with LR's Rules.

(Part only shown)

3.8.4 The following class notations are associated with navigation safety, and may be assigned:

~~**NAV**~~ ~~This notation will be assigned when a superior bridge layout and level of navigation equipment are provided. It denotes that the navigational installation has been arranged, installed and tested in accordance with LR's Rules, or is equivalent thereto.~~

3.9 Other notations

3.9.2 **LA**. This special feature Class notation is mandatory where the vessel has fitted onboard lifting appliances which are considered by LR to be essential for it to fulfil its primary operational role (e.g. Aircraft lifts on aircraft carriers, Landing platform dock stern ramp) and that there are no alternative means of operation. The lifting appliance is to be designed, built and surveyed in accordance with LR's Code for Lifting Appliances in a Marine Environment (LAME).

(Part only shown)

~~*3.9.2*~~ *3.9.3* ~~**LA**~~ **LAP**. This optional special feature Class notation will be assigned to the ship in respect of the lifting appliances fitted which are designed and built in accordance with LR's *Code for Lifting Appliances in a Marine Environment* (LAME) or equivalent standard, but where it is not mandated by the LA notation, *see* 3.9.2. This notation will be assigned in association with a register of lifting appliances listing the appliances covered. The register, which is to be attached to the Classification Certificate, is the responsibility of the designer/Owner and should include the following lifting appliances, where fitted as appropriate:

(a) Bow, side and stern doors serving as ramps and/or serve to provide watertight integrity of the ship.
(b) Vehicle ramps.
(c) ~~Moveable~~ Movable decks.
(d) ~~Aircraft lifts, stores~~ Stores lifts and munitions lifts.

CORRIGENDA

(Part only shown)

3.9.3

~~(k) Lifting points on vessels which are launched and recovered by a lifting appliance, *see* Pt 3, Ch 5,11.4.~~
~~(l)~~ (k) Miscellaneous lifting positions.
~~(m)~~(l) Towed body attachments.

The notation will be retained so long as the appliances are found upon examination by LR at the prescribed surveys to be maintained in accordance with the standard.

Effective date 1 January 2009

Existing paragraphs 3.9.3 to 3.9.22 are to be renumbered 3.9.4 to 3.9.23.

■ *Section 6* Classification of machinery with [✠]LMC or MCH notation

6.2 Appraisal and records

6.2.1 To facilitate survey and compilation of classification records, the same plans and information that are required for a ship being accepted into class with the ✠**LMC** notation, are required to be submitted for the alternative notation ✠ **LMC** or **MCH** for for appraisal and information. Plans are not required where machinery and equipment has previously been type approved, in these cases it is only necessary to submit details of the machinery and equipment together with details of the previous approval.

Volume 1, Part 1, Chapter 3
Periodical Survey Regulations

Effective date 1 January 2009

■ *Section 2* Annual Surveys – Hull, machinery and optional requirements

2.2 Hull

2.2.7 The surveyor is to be satisfied that any alterations to approved scantlings and arrangements to the structure of magazine spaces have been approved by LR, *see* Ch 2,4.4.7.

Existing paragraphs 2.2.7 to 2.2.10 are to be renumbered 2.2.8 to 2.2.11.

2.3 Machinery

2.3.10 The main propulsion, essential auxiliary and emergency generators including safety arrangements, controls and foundations are to be generally examined. Surveyors are to confirm the Periodical Surveys of engines have been carried out as required by the Rules and that safety devices have been tested.

Existing paragraphs 2.3.10 and 2.3.11 are to be renumbered 2.3.11 and 2.3.12.

~~*2.3.12* For ships having **UMS** or **CCS** notation, a General Examination of automation equipment is to be carried out. Satisfactory operation of safety devices and control systems is to be verified. The Surveyor is to be satisfied regarding the efficient condition of bilge level detection and alarm systems on ships assigned a **UMS** notation.~~

2.3.13 For ships fitted with automation equipment for main propulsion, essential auxiliary and emergency machinery, a general examination of the equipment and arrangements is to be carried out. Records of changes to the hardware and software used for control and monitoring systems for propelling and essential auxiliary machinery since the original issue (and their identification) are to be reviewed by the attending Surveyor. Satisfactory operation of the safety devices and control systems is to be verified.

2.3.14 For ships fitted with an electronically controlled engine for main propulsion, essential auxiliary and emergency power purposes the following is to be carried out to the satisfaction of the Surveyor:
(a) A general examination of the electronic control system and associated parts.
(b) Verification of evidence of satisfactory operation of the engine and where possible this is to include a running test under load.
(c) Verification of satisfactory operation of the safety devices and control systems.
(d) Verification that any changes to hardware and software for control of the engine have been submitted and approved by LR.
(e) Verification that any changes to control and monitoring arrangements that affect the operation of the engine have been submitted and approved by LR.
(f) Verification that where changes have been carried out, there is evidence of acceptance tests and trials for Programmable Electronic Systems which include confirmation of software life cycle activities appropriate to the stage in the system's life cycle at the time of system examination.
(g) Identification and verification that the key monitoring parameters/sensors are in working order.

Existing paragraphs 2.3.13 to 2.3.15 are to be renumbered 2.3.15 to 2.3.17.

2.3.18 The surveyor is to be satisfied that any alterations to approved equipment, piping, cabling and electrical systems in magazine spaces have been approved by LR, *see* Ch 2,4.4.7.

Volume 1, Part 3, Chapter 3
Ship Control Systems

Effective date 1 January 2009

■ *Section 2* **Rudders**

2.6 Rudder profile coefficient, K_2

Table 3.2.1 Rudder profile coefficient, K_2

Design criteria (*see* Fig. 3.2.2)	K_2 ahead condition	K_2 astern condition
Normal profile	1,0	0,97
Hollow profile	1,25	1,12
High lift profile	1,7	To be specifically considered
Symbols		
K_2 = rudder profile coefficient for use in 2.11.1		
NOTE Where a rudder is behind a fixed nozzle, the value of K_2 given above, is to be multiplied by 1,3.		

2.7 Rudder angle coefficient, K_3

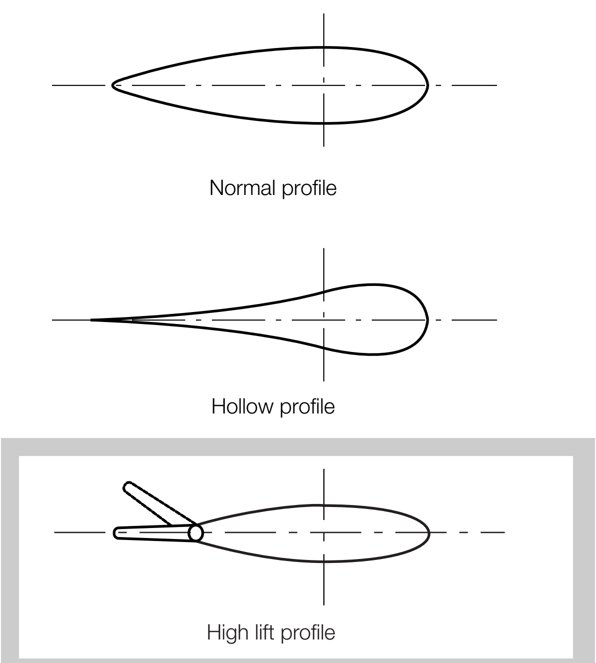


Fig. 3.2.2 Rudder profiles

2.10 Centre of pressure

Table 3.2.4 Rudder speed coefficient, K_5

Design criteria	K_5
Ships with $\dfrac{V}{\sqrt{L_{WL}}} < 3,0$	1,00
Ships with $\dfrac{V}{\sqrt{L_{WL}}} \geq 3,0$	$(1,12 - 0,005V)^3$
Symbols	
$\cancel{L_R}$ L_{WL} as defined in Ch 1,~~5.2.2~~ 5.2.1 V as defined in 2.11 K_5 rudder speed coefficient for use in 2.11.1	

Volume 1, Part 3, Chapter 5

Anchoring, Mooring, Towing, Berthing, Launching, Recovery and Docking

CORRIGENDA

■ *Section 10* Launch and recovery, berthing and docking arrangements

10.1 Berthing loads

10.1.1 To resist loads imposed by tugs and berthing operations all structure within a 1,0 m strip centred 1,0 m above the deep waterline. It should be able to withstand the following pressure P_b:

$$P_b = \left(\frac{g\Delta}{800}\right) \cancel{\text{kN/m}^2}\ \text{kN/m}$$

where

Δ = deep displacement, in tonnes.

Volume 1, Part 4, Chapter 1

Military Design

Effective date 1 January 2009

■ *Section 7* Design guidance for nuclear, biological and chemical defence

7.3 NS1 and NS2 ship requirements

7.3.2 Unless otherwise required by the Naval Authority, the citadel's length is to be divided into ~~a minimum of four~~ zones ~~each with a maximum length of 30 m. The combined length of adjacent zones is to be greater than 0,3L_{WL} and less than 0,5L_{WL}. The~~ . It is recommended that the zone boundaries ~~are to~~ coincide with main transverse watertight bulkheads and extend from the keel to the highest superstructure deck.

Volume 1, Part 4, Chapter 2
Military Load Specification

CORRIGENDA

■ *Section 10* Aircraft operations

10.8 Deck plating design

Table 2.10.6 Design load cases for primary and secondary deck stiffening and supporting structure

Condition	Loading					
		Stiffening			Support structure	
	Plate, F_{typ} kN	P_{tyw}, kN/m^2	Point loads, F_{tys} kN	Self weight, F_{tym} kN	Vertical kN	Horizontal kN
Emergency landing	$\lambda\ f\ W_{ty}$	0,2	$DLF\ \lambda\ f\ W_{ty}$	$(1 + a_z)\ W_s$	Self weight W_{pl} plus landing loads from all wheels	0,5 W_{auw}
Normal landing	0,6 $\lambda\ W_{ty}$	0,5	0,6 $DLF\ \lambda\ W_{ty}$	$(1 + a_z)\ W_s$		0,5 W_{auw} + 0,5 W_{pl}
Take off (fixed wing)	2,65 W_{ty}	0,5	2,65 W_{ty}	$(1 + a_z)\ W_s$		
Manoeuvring internal	1,6 W_{ty}	–	1,6 W_{ty}	$(1 + a_z)\ W_s$		
Manoeuvring external	1,75 W_{ty}	0,5	1,75 W_{ty}	$(1 + a_z)\ W_s$		
Parking internal	$(1 + 0{,}6a_z)\ W_{ty}$	–	$(1 + 0{,}6a_z)\ W_{ty}$	$(1 + a_z)\ W_s$		
Parking external	$1{,}1(1 + 0{,}6a_z)\ W_{ty}$	2	$1{,}1(1 + 0{,}6a_z)\ W_{ty}$	$(1 + a_z)\ W_s$		

W_{ty} W_{auw} and f as defined in 10.5
λ is defined in 10.8
W_{pl} = structural weight of aircraft platform, in kN
W_s = structural weight of stiffener and supported structure, in kN ~~is defined in 10.8~~
P_{tyw} = uniformly distributed vertical load over entire landing area, kN/m^2
DLF = Dynamic load factor — Fixed wing 1,35 for secondary stiffening, 1,5 for primary stiffening; Helicopters 1,2 for secondary stiffening, 1,5 for primary stiffening
a_z is defined in Pt 5, Ch 3,2

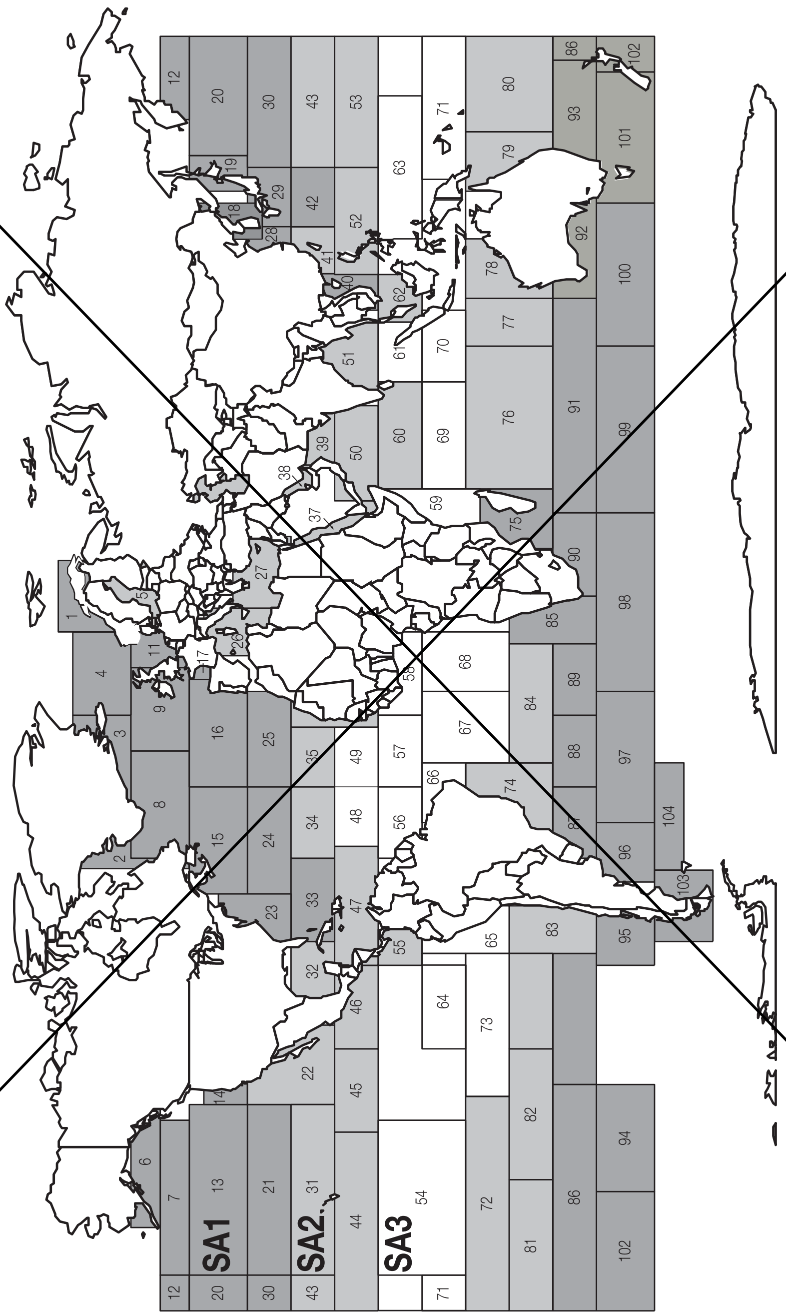
NOTES
1. For the design of the supporting structure for helicopter platforms applicable self weight and horizontal loads are to be added to the landing area loads.
2. The helicopter is to be so positioned as to produce the most severe loading condition for each structural member under consideration.
3. Stiffening members may have more than one point load acting at one time.

Volume 1, Part 5, Chapter 2
Environmental Conditions

CORRIGENDA

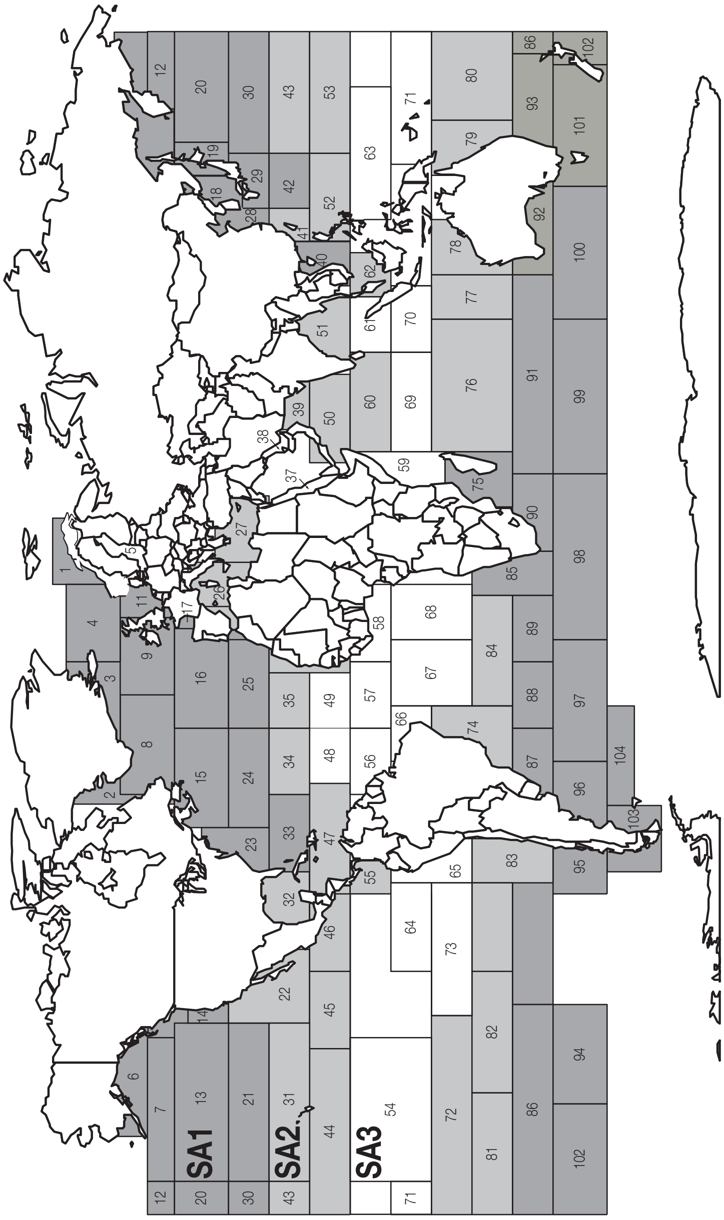
■ *Section 2* **Wave environment**

2.3 Wave environment



Service Area Definitions
Chart shows the minimum required service area notation for each sea area

Fig. 2.2.2 Sea areas



Service Area Definitions
Chart shows the minimum required service area notation for each sea area

Fig. 2.2.2 Sea areas

Volume 1, Part 5, Chapter 3
Local Design Loads

Effective date 1 May 2008

■ *Section 1* Introduction

1.3 Symbols and definitions

1.3.5 **Displacement mode**. Displacement mode means the regime, whether at rest or in motion, where the weight of the ship is fully or predominantly supported by hydrostatic forces. Typically this applies to craft with a Taylor Quotient, Γ, less than 3. However, some craft are designed to plane with Γ less than 3 and these should be considered as operating in the non-displacement mode.

1.3.6 **Fully planing mode or Non-displacement mode**. Non-displacement mode means the normal operational regime of a ship when non-hydrostatic forces substantially or predominantly support the weight of the ship. Typically this applies to craft with a Taylor Quotient, Γ, greater than 3. However, some craft are designed not to plane with Γ greater than 3 and these should be considered as operating in the displacement mode unless they are classified as a high speed craft.

1.3.7 Taylor Quotient Γ. The Taylor Quotient is defined as:

$$\Gamma = \frac{V_m}{\sqrt{L_{WL}}}$$

where

V_m is defined in 1.3.2

L_{WL} is defined in 1.3.1.

CORRIGENDA

■ *Section 3*
Loads on shell envelope

3.3 Hydrostatic pressure on the shell plating, P_h

(Part only shown)

Table 3.3.1 Shell envelope pressure, P_s

Vertical location i.e. z value	Shell envelope pressure, P_s kN/m^2
for $z \leq T_x + z_k \cancel{P_h + P_w}$ i.e. up to the design waterline	$P_h + P_w$

3.4 Hydrodynamic wave pressure, P_w

3.4.1 The hydrodynamic wave pressure distribution, P_w, around the shell envelope up to the design waterline, i.e. $z \leq \cancel{T_x}$ $T_x + z_k$, is to be taken as the greater of the following:

P_m kN/m^2 (relative motion)

P_p kN/m^2 (pitching motion)

where

P_m and P_p are defined in 3.4.2 and 3.4.3.

Volume 1, Part 5, Chapter 4
Global Design Loads

Effective date 1 May 2008

■ *Section 1*
General

1.2 Definitions and symbols

1.2.1 L_R, B, B_{WL}, D and T are defined in Pt 3, Ch 1,5. F_n and Δ are defined in Ch 3,1.3.2 and Ch 3,1.3.1 respectively. Displacement mode and non-displacement mode are defined in Ch 3,1.3.

Volume 1, Part 6, Chapter 4
Hull Girder Strength

CORRIGENDA

■ *Section 4*
Residual Strength Assessment, RSA

4.1 Application

4.2.4 Grounding or raking damage to the bottom structure. The standard grounding damage extent is to be taken as:

Level A

- length of 5 m anywhere forward of midships
- upwards for 1 m or to the underside of the inner bottom, whichever is less
- breadth of 2,5 m.

Level B and C

- length of 0,1$\cancel{L}$ L_R anywhere forward of midships
- upwards for 1 m or to the underside of the inner bottom, whichever is less
- breadth of 5 m.Displacement mode and non-displacement mode are defined in Ch 3,1.3.

Volume 1, Part 6, Chapter 6

Material and Welding Requirements

Effective date 1 August 2008

■ *Section 3*
Requirements for welded construction

3.1 General

~~*3.1.4* The Rules represent the minimum requirement to satisfy classification. It is expected that the quality control procedures in place in the yard will be more stringent than the requirements of these Rules. The procedures should be based on an appropriate National Standard, the requirements of which will be similar to those in LR's *Materials and Qualifications Procedures for Ships*.~~

3.3 Welding equipment

3.3.1 ~~Welding plant and appliances are to be suitable for the purpose intended and properly maintained, taking due cognisance of relevant safety precautions.~~ Welding plant and equipment are to be in accordance with the requirements specified in Ch 13, 1.8 of the Rules for Materials.

~~*3.3.2* Satisfactory storage facilities for consumables are to be provided close to working areas.~~

3.4 Welding consumables

3.4.1 ~~All welding consumables are to be approved by LR and are to be suitable for the type of joint and grade of material, *see* Pt 2, Ch 11.~~ The requirements for welding consumables are to be in accordance with the requirements specified in Ch 13, 1.8 of the Rules for Materials.

~~*3.4.2* Special care is to be taken in the distribution, storage and handling of all welding consumables. They are to be kept in a heated dry storage area with a relatively uniform temperature. Condensation on the metal surface during storage and use is to be avoided. Flux-coated electrodes and submerged arc fluxes are to be stored under controlled conditions. Other welding consumables, such as bare wire and welding studs, are to be stored under dry conditions to prevent rusting. Prior to use, the welding consumables are to be baked as per the manufacturers' recommendations.~~

3.4.2 The approval of welding consumables is to be in accordance with Chapter 11 of the Rules for Materials.

~~*3.4.3* Steel welding consumables approved by LR, up to and including Grade Y40, are considered acceptable for marine construction in line with the following:~~

~~(a) Consumables are acceptable for welding steels up to three strength levels below that for which the approval applies (e.g. 3Y is acceptable for welding 36, 32 and 27S higher tensile ship steels and normal strength ship steel).~~

~~(b) Consumables with an approved impact toughness~~ grading are acceptable for welding steels with lower specified impact properties subject to (a) (e.g. 3Y is acceptable for EH, DH and AH materials).

(c) For joints between steels of different grades or different strength levels, the welding consumables may be of a type suitable for the lesser grade or strength being connected. The use of a higher grade of welding consumable may be required where attachments are made to main structural members of a higher grade or strength.

3.4.4 Where the carbon equivalent, calculated from the ladle analysis and using the formula given below, is in excess of 0,45 per cent, approved low hydrogen welding consumables and preheating are to be used. Where the carbon equivalent is above 0,41 per cent but is not more than 0,45 per cent approved low hydrogen welding consumables are to be used, but preheating will not generally be required except under conditions of high restraint or low ambient temperature. Where the carbon equivalent is not more than 0,41 per cent, welding consumables that have no hydrogen grading may be used and preheating will not generally be required except as above.

$$\text{Carbon equivalent} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

The type of consumable and preheat proposed for low alloy steels will be subject to special consideration.

3.5 Welder qualifications

3.5.1 Welders and welding operators are to be proficient in the type of work on which they are engaged.

3.5.2 The responsibility for selection, training and testing of welding operators rests with the Builders. The Builders are to test welding operators to a suitable National or International Standard. Records of tests and qualifications are to be kept by the Builders and made available to the Surveyor so that he can be satisfied that the personnel employed during the construction of the ship can achieve the required standard of ~~workmanship.~~

~~3.6~~ 3.5 Welding procedures

~~*3.6.1*~~ *3.5.1* ~~Welding procedures, giving details of the welding process, type of consumables, joint preparation and welding position, are to be established for the welding of all joints.~~ Welding procedures are to be established for the welding of all joints in accordance with the requirements specified in Ch 13, 1.9 of the Rules for Materials.

~~*3.6.2*~~ *3.5.2* ~~Welding procedures are to be tested and qualified in accordance with a recognised National or International Standard. For this purpose, the sample joints are to be prepared under conditions similar to those that will occur during construction of the ship.~~ All welding procedures are to be tested and qualified in accordance with the requirements of Chapter 12 of the Rules for Materials and are to be approved by the Surveyor prior to construction.

~~*3.6.3*~~ *3.5.3* ~~The proposed welding procedures are to be agreed with the Surveyor prior to construction.~~ Welders and welding operators are to be proficient in the type of work to be undertaken and are to be qualified in accordance with the requirements specified in Chapter 12 of the Rules for Materials.

~~*3.6.4* Weld repairs, when required, are to be carried out in accordance with the approved procedures, *see also* 3.10.~~

~~3.7 Defined practices and welding sequence~~

3.7.1 A sufficient number of skilled supervisors is to be provided to ensure an effective and systematic control at all stages of welding operations.

3.7.2 Where structural components are to be assembled and welded in works sub-contracted by Builders, the Surveyors are to inspect the sub-contractor's works to ensure that compliance with the requirements of this Chapter can be achieved.

3.7.3 Structural arrangements are to be such as will allow adequate ventilation and access for preheating, where required, and for the satisfactory completion of all welding operations.

3.7.4 The location of welding connections and sequences of welding are to be arranged to minimise restraint. Welding joints are to be so arranged as to facilitate the use of downhand welding wherever possible.

3.7.5 All welding is to be carried out in accordance with the approved welding procedure, *see* 3.6. The welding arrangements and sequence are to be in accordance with the approved plans and agreed with the Surveyor prior to construction.

3.7.6 Careful consideration is to be given to assembly sequence and overall shrinkage of plate panels, assemblies, etc., resulting from welding processes employed. Welding is to proceed systematically with each welded joint being completed in correct sequence without undue interruption. Where practicable, welding is to commence at the centre of a joint and proceed outwards or at the centre of an assembly and progress outwards towards the perimeter so that each part has freedom to move in one or more directions. Generally, the welding of stiffener members, including transverses, frames, girders, etc., to welded plate panels by automatic processes is to be carried out in such a way as to ~~minimise angular distortion of the stiffener.~~

~~*3.7.7* The surfaces of all parts to be welded are to be~~ clean, dry and free from rust, scale and grease. Where manual arc welding is used, each run of deposit is to be effectively clean and free from slag before the next run is applied. Before a sealing run is applied to the back of the weld, the root is to be back chipped, ground or air-arc gouged to sound metal. With other multi-run welding processes back gouging before the application of a sealing run may not be necessary. When air-arc gouging is used for this operation, special care is to be taken to ensure that the ensuing groove is slag free and has a profile suitable for the completion of welding.

3.7.8 Where prefabrication primers are applied over areas which will be subsequently welded, they are to be of a quality acceptable to LR as having no significant deleterious effect on the finished weld, *see* Pt 6, Ch 6,2.6.

3.7.9 All joints are to be properly aligned and closed or adjusted before welding. Excessive force is not to be used in fairing and closing the work. Where excessive gaps exist between surfaces or edges to be joined, the corrective measures adopted are to be to the satisfaction of the Surveyor. Provision is to be made for retaining correct alignment during welding operations. Clamps with wedges or strong-backs used for this purpose are to be suitably arranged to allow freedom of lateral movement between adjacent elements.

3.7.10 Tack welds are to be kept to the minimum and are to be made in accordance with the approved welding procedure. Tack welds which are to be retained as part of the finished weld are to be clean and free from defects. Care is to be taken when removing tack welds used for assembly to ensure that the material of the structure is not damaged.

3.7.11 Generally, tack welds are not to be applied in lengths of less than 30 mm for mild steel grades and 50 mm for higher tensile steel grades.

3.7.12 Special attention is to be given to the examination of plating in way of all lifting eye plate positions to ensure freedom from cracks. This examination is not only restricted to the positions where eye plates have been removed but should also includes the positions where lifting eye plates are permanent fixtures.

3.7.13 Welded temporary attachments used to aid construction are to be removed carefully by grinding or cutting. The surface of the material is to be finished smooth by grinding followed by crack detection.

3.7.14 Where complete removal of lifting lug attachments is required, it is recommended they be burned off at the top of the fillet weld connections and the remainder chipped and ground smooth. However, alternative methods of removing these attachments will be considered.

3.7.15 Any defects in the structure resulting from the removal of temporary attachments are to be repaired.

3.7.16 When modifications or repairs have been made which result in openings having to be closed by welded inserts, particular care is to be given to the fit of the insert and the welding sequence. The welding should also be subject ~~to non-destructive examination.~~

~~*3.7.17* Fairing, by linear or spot heating, to correct~~ distortions due to welding, is to be carried out using approved procedures in order to ensure that the properties of the material are not adversely affected. Visual examination of all heat affected areas and welds in the vicinity is to be carried out to ensure freedom from cracking.

3.7.18 All major welding operations should be complete prior to final machining operations on, for example, rudders sterntubes, propeller brackets and jet units.

3.7.19 Preheating is to be applied in accordance with the approved procedure. When the ambient temperature is below 5°C or where moisture resides on the surface to be welded, due care should be taken to prewarm and dry the joint preparation.

3.7.20 Adequate protection is to be provided where welding is required to be carried out in exposed positions in wet, windy or cold weather.

3.7.21 Special attention is to be paid to preheating when low hydrogen electrodes are used for higher tensile steels on thick materials under high restraint or when applying small ~~weld beads.~~

~~3.8~~ 3.6 Inspection

~~*3.8.1*~~ *3.6.1* Effective arrangements are to be provided by the Shipbuilder for the ~~visual~~ inspection of all finished welds in order to ensure that all welding has been satisfactorily completed.

~~*3.8.2* Welds are to be clean and free from paint at the time of visual inspection.~~

~~*3.8.3* Welds may be coated with a thin layer of protective primer prior to inspection provided it does not interfere with inspection and is removed, if required by the Surveyor, for closer interpretation of possible defect areas.~~

~~*3.8.4*~~ *3.6.2* ~~All finished welds are to be of an acceptable quality in accordance with 3.9.~~ All finished welds are to be subjected to non-destructive examination in accordance with the requirements specified in Ch 13, 2.12 of the Rules for Materials. Details of weld defect levels are given in the Naval Survey Guidance for Steel Ships.

~~*3.8.5* Visual examination of all the welds may be supplemented by other non-destructive examination techniques in cases of unclear interpretation, as considered necessary by the Surveyor.~~

~~*3.8.6* In addition to visual inspection, welded joints are to be examined using any one or a combination of ultrasonic, radiographic, magnetic particle, eddy current, dye penetrant or other acceptable methods appropriate to the configuration of the weld.~~

~~*3.8.7*~~ *3.6.3* Typical locations for volumetric examination and number of checkpoints to be taken are as shown in Table 6.3.1. A list of the proposed items to be examined is to be submitted for approval.

~~*3.8.8* The method to be used for the volumetric~~ examinations of welds is the responsibility of the Shipbuilder. Radiography is generally preferred for the examination of butt welds of 15 mm thickness or less. Ultrasonic testing is acceptable for welds of 15 mm thickness or greater and is to be used for the examination of full penetration tee butt or cruciform welds or joints of similar configuration.

3.8.9 Non-destructive examinations are to be made in accordance with approved written procedures prepared by the Shipbuilder, which identify the method and technique to be used, the extent of the examination and the acceptance criteria to be applied.

3.8.10 Non-destructive examinations are to be undertaken by personnel qualified to the appropriate level of a certification scheme recognized by LR.

3.8.11 Checkpoint examinations at the sub-assembly stage are to include ultrasonic testing on examples of the stop/start points of automatic welding and magnetic particle inspections of weld ends.

3.8.12 Checkpoint examinations at the construction stage are generally to be selected from those welds intended to be examined as part of the agreed quality control programme to be applied by the Shipbuilder. The locations and numbers of checkpoints are to be agreed between the Shipbuilder and the Surveyor.

3.8.13 Where components of the structure are subcontracted for fabrication, the same inspection regime is to be applied as if the item had been constructed within the shipyard. In these cases, particular attention is to be given to highly loaded fabrications (such as stabilizer fin boxes) forming an integral part of the hull envelope.

3.8.14 Particular attention is to be paid to highly stressed items. Magnetic particle inspection is to be used at the ends of fillet welds, T-joints, joints or crossing in main structural members.

3.8.15 Checkpoints for volumetric examinations are to be selected so that a representative sample of all types of weld are examined.

3.8.16 For the hull structure of refrigerated spaces, and of ships designed to operate in low air temperature, the extent of non-destructive examination will be specially considered.

3.8.17 For all ship types, the Shipbuilder is to carry out random non-destructive examination at the request of the Surveyor.

3.8.18 The full extent of any weld defect is to be ascertained by applying additional non-destructive examinations where required. Unacceptable defects are to be completely removed and where necessary, re-welded. The repair is to be examined after re-welding by the same method used to detect the defect.

3.8.19 Results of non-destructive examinations made during construction are to be recorded and evaluated by the Shipbuilder on a continual basis in order that the quality of welding can be monitored. These records are to be made ~~available to the Surveyor.~~

~~*3.8.20* The extent of applied non-destructive examinations~~ is to be increased when warranted by the analysis of previous results.

3.9 Acceptance criteria

3.9.1 All finished welds are to be sound and free from cracks, lack of fusion, incomplete penetration, and substantially free from porosity and slag. The surfaces of welds are to be reasonably smooth and substantially free from undercut and overlap. Care is to be taken to ensure that the specified dimensions of welds have been achieved and that both excessive reinforcement and underfill of welds are avoided. Details of weld defect levels are given in the Naval Survey Guidance for Steel Ships.

3.10 Weld repair

3.10.1 Repairs to defective welding are to be carried out using approved welding consumables and procedures. The repair is to be re-examined.

3.10.2 Major repairs should not be carried out without prior approval of the Surveyor.

3.10.3 Repairs to defects found in the base materials during construction should not be carried out without prior approval of the Surveyor. If repairs are agreed these should be carried out in accordance with the requirements of the relevant Section of Part 2, using qualified welding procedures.

3.10.4 When misalignment of structural members either side of bulkheads, decks, etc., exceeds the agreed tolerance, the misaligned item is to be released, realigned and rewelded ~~in accordance with an approved weld repair procedure.~~

■ *Section 4*
Welded joints and connections

4.4 Butt welds

~~*4.4.2* Abrupt changes of section are to be avoided where plates of different thicknesses are to be butt welded. Where the difference in thickness exceeds 3 mm, the thicker plate to be welded is to be prepared with a taper not exceeding one in three or with a bevelled edge to form a welded joint proportioned correspondingly. Where the difference in thickness is less than 3 mm, the transition may be achieved within the width of the weld. Difference in thickness greater than 3 mm may be accepted provided it can be proven by the Builder, through procedure tests, that the Rule transition shape can be achieved and that the weld profile is such that structural continuity is maintained to the Surveyor's satisfaction. For ships with shock enhanced notation, *see* Pt 4, Ch 2,4.~~

~~*4.4.3* Where stiffening members are attached by continuous fillet welds and cross completely finished butt or seam welds, these welds are to be made flush in way of the faying surface. Similarly, for butt welds in webs of stiffening members, the butt weld is to be completed and generally made flush with the stiffening member before the fillet weld is made. The ends of the flush portion are to run out smoothly without notches or sudden change of section. Where these conditions cannot be complied with, a scallop is to be arranged in the web of the stiffening member. Scallops are to be of such size, and in such a position, that a satisfactory weld can be made, *see* Pt 3, Ch 2,3.~~

Existing paragraph 4.4.4 is to be renumbered 4.4.2.

4.4.3 For ships with shock enhanced notation, *see* Pt 4, Ch 2,4.

4.5 Fillet welds

~~*4.5.1* T-connections are generally to be made by fillet welds on both sides of the abutting plate, the dimensions and spacing of which are shown in Fig. 6.4.1. Where the connection is highly stressed full penetration welding may be required. Where full penetration welding is required, the abutting plate may need to be bevelled.~~

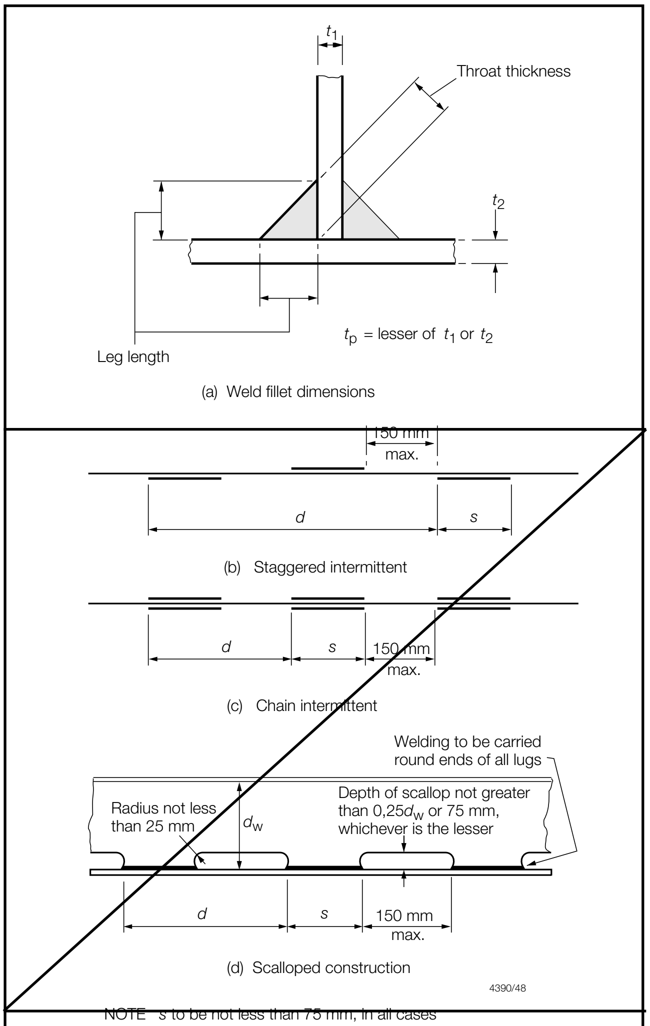


Fig. 6.4.1 Weld ~~types~~ fillet dimensions

Existing paragraphs 4.5.2 and 4.5.3 are to be renumbered 4.5.1 and 4.5.2.

~~*4.5.4* Where an approved automatic deep penetration procedure is used, the weld factors given in Table 6.4.1 may generally be reduced by 15 per cent. Consideration may be given to reductions of up to 20 per cent.~~

Existing paragraphs 4.5.5 to 4.5.7 are to be renumbered 4.5.3 and 4.5.5.

4.9 Intermittent welding (staggered and chain)

~~*4.9.2* Where staggered intermittent welding is used, the welding is to be made continuous round the ends of brackets, lugs, scallops, etc.~~

Existing paragraphs 4.9.3 to 4.9.7 are to be renumbered 4.9.2 and 4.9.6.

~~**4.10 Slot welding**~~

4.10.1 For the connection of plating to internal webs where access for welding is not practicable, the closing plating is to be attached by continuous full penetration welds, or by slot fillet welds to face plates fitted to the webs. Slots are, in general, to have a minimum length of ten times the plating thickness or 75 mm, whichever is the lesser, but in no case to be taken as less than 40 mm, and a minimum width of twice the plating thickness or 15 mm whichever is the greater, with well rounded ends. Slots cut in plating are to have smooth, clean and flat edges and the distance between the slots is, in general, not to exceed 150 mm. Slots are not to be filled with welding. Alternative proposals for length, width and spacing of slot welds will be specially considered. ~~For rudder closing plates, *see* Pt 3, Ch 3,2.18.4.~~

~~**4.11 Stud welding**~~

4.11.1 Where permanent or temporary studs are to be attached by welding to main structural parts in areas subject to high stress, the proposed location of the studs and the welding procedures adopted are to be tested to the satisfaction of the Surveyors.

4.12 Lap connections

4.12.1 Overlaps are generally not to be used to connect plates which may be subjected to high tensile or compressive loading and alternative arrangements are to be considered. Where, however, plate overlaps are adopted, the width of the overlap is not, in general to exceed four times nor be less than three times the thickness of the thinner plate and the joints are to be positioned so as to allow adequate access for completion of sound welds. The faying surfaces of lap joints are to be in close contact and both edges of the overlap are ~~to have continuous fillet welds.~~

Existing sub-Sections 4.13 to 4.16 are to be renumbered 4.10 and 4.13.

Volume 2, Part 1, Chapter 1

General Requirements for Classification of Engineering Systems

Effective date 1 January 2009

■ *Section 7*
Certification of materials

7.2 Welding

7.2.1 Welding consumables, plant and equipment are to be in accordance with the requirements specified in Ch 13, 1.8 of the Rules for Materials.

7.2.2 Welding procedures and welder qualifications are to be tested and qualified in accordance with the requirements specified in Chapter 12 of the Rules for Materials.

7.2.3 Production weld tests are to be carried out where specified in the subsequent Chapters of these Rules.

7.2.4 All finished welds are to be subjected to non-destructive examination in accordance with the requirements specified in Ch 13, 2.12 of the Rules for Materials and or the requirements specified in the subsequent chapters of these Rules.

Volume 2, Part 1, Chapter 2

Requirements for Design, Construction, Installation and Sea Trials of Engineering Systems

Effective date 1 January 2009

Section 6
Diesel engines

6.2 Construction and welding

6.2.1 ~~Where engine structures are fabricated, assembly is to be carried out to an approved welding and stress relief heat treatment procedure.~~ Welding of engine structures is to be in accordance with the requirements specified in Chapter 13 of the Rules for Materials.

6.4 Non-destructive testing

6.4.1 ~~Non-destructive tests of components are to be carried out to an approved procedure. *See also* Vol 1, Pt 2, Ch 1,12.~~ Non-destructive examination of welded construction is to be conducted in accordance with the requirements specified in Chapter 13 of the Rules for Materials.

Section 10
Gearing

10.2 Construction and welding

10.2.2 ~~Where welding is employed in the construction of wheels and gearcases, the welding procedure is to be approved before work is commenced. For this purpose, welding procedure approval tests are to be carried out with satisfactory results. Such tests are to be representative of the joint configuration and materials. All welds are to have a satisfactory surface finish and contour. Magnetic particle or liquid penetrant examination of all important welded joints is to be carried out.~~ Where welded construction is used for the manufacture of wheels and gearcases, welding is to be in accordance with the requirements specified in Chapter 13 of the Rules for Materials.

Section 13
Water jet units

13.2 Construction and welding

13.2.2 Welded construction is to be in accordance with the requirements specified in Chapter 13 of the Rules for Materials.

Existing paragraph 13.2.2 is to be renumbered 13.2.3.

Section 16
Sea trials

16.3 Performance testing

16.3.6 The following information is to be available onboard for the use of designated personnel:

- The results of trials to determine stopping times, ship headings and distance;
- For ships having multiple propellers, the results of trials to determine the ability to navigate and manoeuvre with one or more propellers inoperative.

16.3.7 It is to be demonstrated at the sea trial that the stopping distance achieved when the ship is initially proceeding ahead with a speed of at least 90 per cent of the ship's speed corresponding to 85 per cent of the maximum rated propulsion power should not exceed 15 ship lengths after the astern order has been given. However, if the displacement of the ship makes this criterion impracticable then in no case should the stopping distance exceed 20 ship lengths.

Volume 2, Part 1, Chapter 3

Requirements for Fusion Welding of Pressure Vessels and Piping

Effective date 1 January 2009

■ *Section 1* General

1.1 Scope

~~*1.1.3* The term 'fusion weld', for the purpose of these requirements, is applicable to welded joints made by manual, semi-automatic or automatic electric arc welding processes. Special consideration will be given to the proposed use of other fusion welding processes, *see* Section 6 for oxy-acetylene welding of pipes.~~

Existing paragraph 1.1.4 is to be renumbered 1.1.3.

1.2 General requirements for welding plant and welding quality

1.2.1 In the first instance, and before work is commenced, the Surveyors are to be satisfied that the required quality of welding is attainable with the proposed welding plant, equipment and procedures in accordance with the guidelines specified in *Materials and Qualification Procedures for Ships Book A, Procedure 0-4*.

~~*1.2.2* The procedures are to include the regular systematic supervision of all welding, and the welders are to be subjected by the work's supervisors to periodic tests for quality of workmanship. Records of these tests are to be kept and are to be available for inspection by the Surveyors.~~

~~*1.2.3*~~ *1.2.2* All welding is to be ~~to the satisfaction of the Surveyors~~ in accordance with the requirements specified in Chapter 13 of the Rules for Materials.

■ *Section 2* Manufacture and workmanship of fusion welded pressure vessels

2.2 Materials of construction

~~*2.2.1* Materials used in welded construction are to be readily weldable and shall have proven weldability.~~

~~*2.2.2* Materials are to be supplied by firms that have been approved in accordance with Vol 1, Part 2.~~

~~*2.2.3* Where the construction details are such that materials are subject to through thickness strains, consideration should be given to using materials with specified through thickness properties as specified in Vol 1, Part 2.~~

~~*2.2.4*~~ *2.2.1* Where the construction requires post weld heat treatment, consideration should be given to certifying the material after subjecting the test pieces to a simulated heat treatment.

2.2.2 Pressure vessels are to be constructed and examined in accordance with the requirements specified in Chapter 13 of the Rules for Materials, unless more stringent requirements are specified.

~~*2.2.5* The identity of materials is to be established by way of markings, etc., so that traceability to the original manufacturer's certificate is maintained.~~

~~2.3 Cutting of materials~~

2.3.1 Materials may be cut to the required dimensions by thermal means, shearing or machining in accordance with the manufacturing drawings or specifications.

2.3.2 Cold shearing should not be used on materials in excess of 25 mm thick and, where used, the cut edges are to be cut back by machining or grinding for a minimum distance of 3 mm.

2.3.3 Material which has been thermally cut is to be machined or ground back to remove all oxides, scale and notches.

2.3.4 Thermal cutting of alloy and high carbon steels may require the application of preheat, and special examination of these cut edges will be required to ensure freedom from cracking. In these cases the cut edges are to be machined or ground back a distance of at least 2,0 mm, unless it has been demonstrated that the cutting process has not damaged the material.

2.3.5 Any material damaged in the process of cutting is to be removed by machining, grinding or chipping back to sound metal; weld repair may only be performed with the agreement of the Surveyors.

2.3.6 All plate edges, after being cut shall be examined for defects, including laminations, to ensure that these are free from cracks. Visual methods may be augmented by other techniques at the discretion of the Surveyors.

2.3.7 Edges that have been cut by machining or chipping, which will not be subsequently covered by weld metal, are to be ground smooth.

2.4 Forming shell sections and end plates

2.4.1 Shell plates and heads are to be formed to the correct contour up to the extreme edge of the plate.

2.4.2 Plates may be formed to the required shape either hot or cold and by any process that does not impair the quality of the material. Tests to demonstrate the suitability of the forming process may be requested at the discretion of the Surveyors.

2.4.3 Wherever possible, forming is to be performed by the application of steady continuous loading using a machine designed for that purpose. The use of hammering, in either the hot or cold condition should not be employed.

2.4.4 Material may be welded prior to forming or bending, provided that it can be demonstrated that the mechanical properties of the welds are not impaired by the forming operation. All welds subjected to bending are to be inspected on completion to ensure freedom from surface breaking defects.

2.4.5 Vessels manufactured from carbon or carbon manganese steel plates which have been hot formed or locally heated for forming are to be re-heat treated in accordance with the original supplied condition on completion of this operation. Vessels formed from plates supplied in the as-rolled condition shall be heat treated in accordance with the material manufacturer's recommendations.

2.4.6 Where these steels are supplied in the as-rolled, normalized or normalized rolled condition, if hot forming is carried out entirely at a temperature within the normalizing range, subsequent heat treatment will not be required.

2.4.7 For alloy steel vessels, where hot forming is employed, the plates are to be heat treated on completion in accordance with the material manufacturer's recommendations.

2.4.8 Where plates are cold formed, subsequent heat treatment is to be performed where the internal radius is less than 10 times the plate thickness. For carbon and carbon-manganese steels this heat treatment may be a stress relief heat treatment.

2.4.9 In all cases where hot forming is employed, and for cold forming to an internal radius less than 10 times the thickness, the manufacturer is required to demonstrate that the forming process and subsequent heat treatments result in acceptable properties.

2.5 Fitting of shell plates and attachments

2.5.1 Careful consideration is to be given to the assembly sequence to be employed, in order to minimize overall shrinkage and distortion and to reduce the build up of residual stresses.

2.5.2 Excessive force is not to be used in fairing and closing the work. Where excessive root gaps exist between surfaces or edges to be joined, the corrective measures adopted are to be to the satisfaction of the Surveyors.

2.5.3 Provision is to be made for retaining correct alignment during welding operations.

2.5.4 In all cases where tack welds are used to retain plates or parts in position prior to welding, they are to be made using approved welding procedures.

2.5.5 Where temporary bridge pieces or strong-backs are used they are to be of similar materials to the base materials and are to be welded in accordance with approved welding procedures.

2.5.6 Where welding to clad materials, any fit-up aids and tack welds are to be attached to the base materials and not to the cladding.

2.5.7 The location of welded joints are to be such as to avoid intersecting butt welds in the vessel shell plates. The attachment of nozzles and openings in the vessels are to be arranged to avoid main shell weld seams.

2.5.8 The surfaces of the plates at the longitudinal or circumferential seams are not to be out of alignment with each other, at any point, by more than 10 per cent of the plate thickness. In no case is the mis-alignment to exceed 3 mm for longitudinal seams, or 4 mm for circumferential seams.

2.5.9 Where a vessel is constructed of plates of different thicknesses (tube plate and wrapper plate), the plates are to be so arranged that their centrelines form a continuous circle.

2.5.10 For longitudinal seams, the thicker plate is to be equally chamfered inside and outside by machining over a circumferential distance not less than twice the difference in thickness, so that the plates are of equal thickness at the longitudinal weld seam. For the circumferential seam, the thickest plate is to be similarly prepared over the same distance longitudinally.

2.5.11 For the circumferential seam, where the difference in the thickness is the same throughout the circumference, the thicker plate is to be reduced in thickness by machining to a taper for a distance not less than four times the offset, so that the two plates are of equal thickness at the weld joint. A parallel portion may be provided between the end of the taper and the weld edge preparation; alternatively, if so desired, the width of the weld may be included as part of the smooth taper to the thicker plate.

2.6 Welding during construction

2.6.1 Welding plant and equipment is to be suitable for the purpose intended and properly maintained, taking due cognisance of relevant safety precautions. Electrical meters are to be properly maintained and have current calibrations.

2.6.2 Welding consumables are to be suitable for the type of joint and grade of material to be welded and satisfactory storage and handling facilities are to be provided close to working areas.

2.6.3 Prior to use, welding consumables should be dried and/or baked in accordance with the consumable manufacturer's recommendations. The condition of welding consumables shall be subject to regular inspections.

2.6.4 All welders and welding operators are to be suitably skilled and qualified for the type of welding work to be undertaken.

2.6.5 Welding procedures are to be established for all welds joining pressure containing parts and for welds made directly onto pressure containing parts.

~~*2.6.6* Welding should be performed, wherever possible,~~ in covered workshops. Where this is not possible, provision is to be made in the welding area to give adequate protection from wind, rain and cold, etc.

2.6.7 Surfaces of all parts to be welded are to be clean, dry and free from rust, scale and grease. Where prefabrication primers are applied over areas which will be subsequently welded, they are to be approved for that application.

2.6.8 Preheat shall be applied, as specified in the approved welding procedure, for a distance of at least 75 mm from the joint preparation edges. The method of application and temperature control are to be such as to maintain the required level during welding and is to be to the satisfaction of the Surveyors.

2.6.9 When the ambient temperature is 0°C or less, or where moisture resides on the surfaces to be welded, due care should be taken to pre-warm and dry the weld joint.

2.6.10 The welding arc is to be struck on the parent metal which forms part of the weld joint or on previously deposited weld metal.

2.6.11 Tack welds made in the root of the weld joint are to be removed in the process of welding the seam.

2.6.12 Where the welding process used is slag forming (e.g. manual metal arc, submerged arc, etc.), each run of deposit is to be cleaned and free from slag before the next run is applied.

2.6.13 Wherever possible, full penetration welds are to be made from both sides of the joint. Prior to welding the second side, the weld root is to be cleaned, in accordance with the requirements of the approved welding procedure, to ensure freedom from defects. When air-arc gouging is used, care is to be taken to ensure that the ensuing groove is slag and oxide free and has a profile suitable for welding.

2.6.14 After welding has been stopped for any reason, care is to be taken in restarting to ensure that the previously deposited weld metal is thoroughly cleaned of slag and debris, and preheat has been re-established.

2.6.15 Where welding from one side only cannot be avoided, care is to be exercised to ensure the root gap is in accordance with the approved welding procedure and the root is properly fused.

2.6.16 Steel backing strips may be used for the circumferential seams of Class 2/1, Class 2/2 and Class 3 pressure vessels and are to be the same nominal composition as the plates to be welded.

2.6.17 Fillet welds are to be made to ensure proper fusion and penetration at the root of the fillet. At least two layers of weld metal are to be deposited at each weld affixing branch pipes, flanges and seatings.

2.6.18 Where attachment of lugs, brackets, branches, manhole frames, reinforcement plates and other members are to be made to the main pressure shell by welding, these shall be to the same standard as that required for the main vessel ~~shell construction.~~

~~*2.6.19* The attachment by welding of such fittings to the~~ main pressure shell after post weld heat treatment is not permitted.

2.6.20 Completed welds shall be at least flush with the surface of the plates joined and have the shape and size specified in the approved drawings or specifications. Welds shall have an even contour and blend smoothly with the base materials.

2.6.21 The main weld seams and all welded attachments made to pressure containing parts are to be completed prior to post weld heat treatment. Tubes that have been expanded into headers or drums may be seal welded without further post weld heat treatment.

2.6.22 The finish of welds attaching pressure parts and non-pressure parts to the main pressure shell is to be such as to allow satisfactory examination of the welds. In the case of Class 1 and Class 2/1 pressure vessels, these welds are to be ground smooth, if necessary, to provide a suitable finish ~~for examination.~~

Existing sub-Section 2.7. is to be renumbered 2.3.

■ *Section 3*
Routine weld tests for pressure vessels

Existing Section 3 is to be deleted in its entirety.

■ *Section ~~4~~ 3*
Repairs to welds on fusion welded pressure vessels

~~4.1~~ 3.1 General

~~*4.1.1* Where non-destructive examinations reveal unacceptable defects in the welded seams, they are to be repaired in accordance with the following:~~

~~(a) Major repairs shall not be carried out without the prior consent of the Surveyors.~~

~~(b) Where cracks have developed as a result of welding, these are to be reported to the Surveyors and the cause established prior to undertaking weld repair.~~

~~(c) Defects may be removed by grinding, chipping or thermal gouging. Where thermal gouging is used, the repair groove shall be subsequently ground to remove oxides and debris. In all cases, the groove shall have a profile suitable for welding.~~

~~(d) Prior to commencing repair welding, confirmation that the original defect has been removed is required by performing visual examination. This may be augmented by surface crack detection examination at the discretion of the Surveyors.~~

~~(e) Repair welding is to be performed using welding procedures agreed with the Surveyors.~~

~~(f) Where the pressure vessel requires post weld heat treatment in accordance with Section 5, this shall be performed after completion of the weld repairs.~~

~~(g) Weld repairs are to be shown by further non-destructive examinations to have removed the defect to the Surveyors' satisfaction.~~

3.1.1 Repairs to welds on fusion welded pressure vessels are to be in accordance with the requirements of, Chapter 13 of the Rules for Materials.

~~**4.2 Re-repairs**~~

~~*4.2.1* In general, only two repair attempts are to be made of the same defect. Any subsequent repairs will be at the discretion of the Surveyors and may require the removal of the heat affected zone of the original repair.~~

■ *Section ~~5~~ 4*
Post weld heat treatment of pressure vessels

~~5.1~~ 4.1 General

~~*5.1.1*~~ *4.1.1* ~~Fusion welded pressure vessels, where indicated in Table 3.5.1 are to be heat treated on completion of the welding of the seams and of all attachments to the shell and ends, and before the hydraulic test is carried out.~~ Post weld heat treatment of fusion welded pressure vessels is to be in accordance with the requirements of, Chapter 13 of the Rules for Materials.

~~*5.1.2* Tubes which have been expanded into headers or drums may be seal welded without further post weld heat treatment.~~

~~Table 3.5.1~~ ~~Post weld heat treatment~~ requirements

Type of steel	Plate thickness above which post weld heat treatment (PWHT) is required	
	Steam raising plant	Other pressure vessels
Carbon and carbon/manganese steels without low temperature impact values	20 mm	30 mm
Carbon and carbon/manganese steels with low temperature impact values	20 mm	40 mm
1Cr $^1/_2$Mo	All thicknesses	All thicknesses
2$^1/_4$Cr 1Mo	All thicknesses	All thicknesses
$^1/_2$Cr $^1/_2$Mo $^1/_4$V	All thicknesses	All thicknesses
~~Other alloy steels~~	~~Subject to special consideration.~~	

~~*5.1.3*~~ Where the weld connects parts of different thicknesses, the thickness to be used when applying the requirements for post weld heat treatment is to be either the thinner of the two plates for butt welded connections, or the thickness of the shell for connections to flanges, tubeplates and similar connections.

5.1.4 Parts are to be properly prepared for heat treatment, sufficient temporary supports are to be provided to prevent undue distortion or collapse of the structure and any machined faces are to be adequately protected against scaling.

5.1.5 Care is to be exercised to provide drilled holes in double reinforcing plates and other closed spaces prior to heat treatment.

5.2 Basic requirements for heat treatment of fusion welded pressure vessels

5.2.1 Heat treatment is to be carried out in a properly constructed furnace which is efficiently maintained.

5.2.2 The heat treatment facilities shall be capable of controlling the temperature throughout the heat treatment cycle and adequate means of measuring and recording the vessel temperature are to be provided. To this end, thermo-couples are to be attached such that they are in contact with the vessel.

5.2.3 Unless stated otherwise, post weld heat treatment is to be carried out by means of slow, even heating from 300°C to the soak temperature, holding within the prescribed soaking temperature range for the time specified (usually one hour per 25 mm of weld thickness), followed by slow even cooling to 300°C.

5.2.4 Recommended soaking temperatures and periods are given in Table 3.5.2 for different materials. Where other materials are used for pressure vessel construction, full details of the proposed heat treatment are to be submitted for consideration.

5.2.5 Where pressure vessels are of such dimensions that the whole length cannot be accommodated in the furnace at one time, the pressure vessels may be heated in sections, provided that sufficient overlap is allowed to ensure the heat treatment of the entire length of the longitudinal seam.

5.2.6 Where it is proposed to adopt special methods of heat treatment, full particulars are to be submitted for consideration. In such cases it may be necessary to carry out ~~tests to show the effect of the proposed heat treatment.~~

~~Table 3.5.2 Post weld soak temperatures and times~~

Material type	Soak temperature, °C (*see* Note)	Soak period
Carbon and carbon/manganese grades:	580–620°	1 hour per 25 mm of thickness, minimum of 1 hour
1Cr $^{1}/_{2}$Mo	620–660°	1 hour per 25 mm of thickness, minimum of 1 hour
2$^{1}/_{4}$Cr 1Mo	650–690°	1 hour per 25 mm of thickness, minimum of 1 hour
$^{1}/_{2}$Cr $^{1}/_{2}$Mo $^{1}/_{4}$V	670–720°	1 hour per 25 mm of thickness, minimum of 1 hour
NOTE For materials supplied in the tempered condition, the post weld soak temperature shall be lower than the material tempering ~~temperature.~~		

■ *Section ~~6~~ 5*
Welded pressure pipes

~~6.1~~ 5.1 General

~~6.1.1~~ 5.1.1 ~~Fabrication of pipework is to be carried out in accordance with the requirements of this Section unless other more stringent requirements have been specified.~~ Fabrication of pipework is to be carried out in accordance with the requirements of Ch 13, 5 of the Rules for Materials.

~~*6.1.2* Piping systems are to be constructed in accordance with approved plans and specifications.~~

~~*6.1.3* Pipe welding may be performed using manual, semi-automatic or fully automatic electric arc welding processes. The use of oxy-acetylene welding will be limited to Class 3 pipework in carbon steel material that is not carrying flammable fluids and limited to butt joints in pipes not exceeding 100 mm diameter or 9,5 mm wall thickness.~~

~~*6.1.4* Where pressure pipework is assembled and butt welded *in situ*, the piping is to be arranged well clear of adjacent structures to allow sufficient access for preheating, welding, heat treatment and examination of the joints.~~

~~6.2 Fit-up and alignment~~

6.2.1 Acceptable methods of flange attachment are illustrated in Fig. 1.5.1 in Pt 7, Ch 1. If backing rings are used with flange type (a) then they are to fit closely to the bore of the pipe and should be removed after welding. The rings are to be made of the same material as the pipes. The use of flange types (b) and (c) with alloy steel pipes is limited to pipes up to and including 168,3 mm outside diameter.

6 2.2 Alignment of pipe butt welds shall be in accordance with Table 3.6.1. Where fusible inserts are used the alignment shall be within 0,5 mm in all cases.

Table 3.6.1 Pipe alignment tolerances

Pipe size	Maximum permitted mis-alignment
D < 150ϕ mm and t ≤ 6 mm	1,0 mm or 25% of t whichever is the lesser
D < 300ϕ mm and t ≤ 9,5 mm	1,5 mm or 25% of t whichever is the lesser
D ≥ 300 and t > 9,5 mm	2,0 mm or 25% of t whichever is the lesser
D = t =	pipe internal diameter pipe wall thickness

6.2.3 Where socket welded fittings are employed they are to comply with the requirements of Pt 7, Ch 1,5.5. The diametrical clearance between the outside diameter of the pipe and the bore of the fitting is not to exceed 0,8 mm, and a gap of approximately 1,5 mm is to be provided between the ~~end of the pipe and the bottom of the socket.~~

~~6.3~~ 5.2 Welding workmanship

~~*6.3.1* Welding procedures are to be established for weld~~ing of pipework including attachment welds directly to pressure retaining parts and are to be qualified by testing on simulated joints.

6.3.2 Where the work requires a significant number of branch connections, tests may also be required to demonstrate that the type of joint(s) and welding techniques employed are capable of achieving the required quality.

6.3.3 Welding consumables and, where used, fusible root inserts, are to be suitable for the materials being joined.

6.3.4 For welding of carbon and low alloy steels, preheat is to be applied depending on the material grade, thickness and hydrogen grading of the welding consumable in accordance with Table 3.6.2 unless welding procedure ~~testing indicates that higher levels are required.~~

~~Table 3.6.2 Minimum preheat requirements~~

Material grade	Thickness *t*, in mm (4)	Minimum preheat temperature (1), °C	
		Non-low H_2	Low H_2 (2)
Carbon and carbon/manganese grades: 320 and 360	$t \leq 10$ $t \geq 20$	50 100	10 50
Carbon and carbon/manganese grades: 410, 460 and 490	$t \leq 10$ $t \geq 20$	75 150	20 100
1Cr 1/2Mo	$t < 13$ $t \geq 13$	(3)	100 150
2 1/4Cr 1Mo	$t < 13$ $t \geq 13$	(3)	150 200
1/2Cr 1/2Mo 1/4V	$t < 13$ $t \geq 13$	(3)	150 200

NOTES
1. For thicknesses up to 6 mm, the preheat levels specified may be reduced subject to satisfactory hardness testing during welding procedure qualification.
   In all cases where the ambient temperature is 0°C or below, preheat is required.
2. Low hydrogen process or consumables are those which have been tested and have achieved a grading of H15 or better, *see* Chapter 11 of Vol 1, Part 2.
3. Low hydrogen process is required for these materials.
4. ~~*t* = the thickness of the thicker member.~~

~~6.3.5~~ 5.2.1 Preheating is to be effected by a method which ensures uniformity of temperature at the joint. The method of heating and the means adopted for temperature control are to be to the satisfaction of the Surveyors.

~~6.3.6~~ 5.2.2 All welding is to be performed in accordance with the approved welding procedures (*see* 6.3.1) by welders who are qualified for the materials, joint types and welding processes employed.

~~6.3.7~~ 5.2.3 Welding without filler metal is generally not permitted for welding of duplex stainless steel materials.

~~6.3.8~~ 5.2.4 All welds in high pressure and high temperature pipelines are to have a smooth surface finish and even contour; if necessary, they are to be made smooth by grinding.

~~6.3.9~~ 5.2.5 Check tests of the quality of the welding are to be carried out periodically at the discretion of the Surveyors.

~~6.4 Heat treatment after bending of pipes~~

~~*6.4.1* Heat treatment should be carried out in a suitable furnace provided with temperature recording equipment in accordance with 5.2.~~

~~6.4.2~~ ~~Hot forming should generally be carried out within~~ the normalizing temperature range. When carried out within this temperature range, no subsequent heat treatment is required for carbon and carbon-manganese steels. For alloy steels, 1Cr 1/2Mo, 2 1/4Cr 1Mo and 1/2Cr 1/2Mo 1/4V, a subsequent stress relieving heat treatment in accordance with Table 3.5.2 is required irrespective of material thickness.

6.4.3 When hot forming is performed outside the normalizing temperature range, a subsequent heat treatment in accordance with Table 3.6.3 is required.

Table 3.6.3 Heat treatment after forming of pipes

Type of steel	Heat treatment required
Carbon and carbon/manganese: Grades 320, 360, 410, 460 and 490	Normalize at 880 to 940°C
1Cr 1/2Mo	Normalize at 900 to 940°C, followed by Tempering at 640 to 720°C
2 1/4Cr 1Mo	Normalize at 900 to 960°C, followed by Tempering at 650 to 780°C
1/2Cr 1/2Mo 1/4V	Normalize at 930 to 980°C, followed by Tempering at 670 to 720°C
Other alloy steels	Subject to special consideration

6.4.4 After cold forming to a radius measured at the centreline of the pipe of less than four times the outside diameter, heat treatment in accordance with Table 3.6.3 is required.

6.4.5 The heat treatments specified above shall be applied unless the pipe material manufacturer specifies or recommends other requirements.

6.4.6 Bending procedures and subsequent heat treatment for other alloy steels will be subject to special consideration.

6.5 Post weld heat treatment of pipe welds

6.5.1 Post weld heat treatment shall be carried out in accordance with the general requirements specified in 5.2 for pressure vessels.

6.5.2 Post weld heat treatment is to be performed on steel pipes and fabricated branch pieces on completion of welding where the material thickness exceeds that specified in Table 3.6.4.

Table 3.6.4 Thickness limits for post weld heat treatment of pipe welds

Type of steel	Requirements for heat treatment
Carbon and carbon/manganese: Grades 320, 360, 410, 460 and 490	Thicknesses exceeding 30 mm
1Cr $^1/_2$Mo	Thicknesses exceeding 8 mm
2$^1/_4$Cr 1Mo	All thicknesses
$^1/_2$Cr $^1/_2$Mo $^1/_4$V	All thicknesses
Other alloy steels	Subject to special consideration

6.5.3 Recommended soaking temperatures and periods for post weld heat treatment are given in Table 3.5.2.

6.5.4 Where oxy-acetylene welding has been used, due consideration should be given to the need for normalizing and tempering after such welding.

■ *Section ~~7~~ 6*
Non-Destructive Examination

~~7.1~~ 6.1 General

~~7.1.1~~ 6.1.1 ~~Non-Destructive Examinations (NDE) of pressure vessel welds are to be carried out in accordance with a nationally recognized code or standard.~~ Non-Destructive Examination (NDE) of pressure vessels is to be performed in accordance with the requirements of Ch13, 5 of the Rules for Materials.

~~*7.1.2* NDE should not be applied until an interval of at least 48 hours has elapsed since the completion of welding.~~

7.2 NDE personnel

7.2.1 NDE Personnel are to be qualified to an appropriate level of a nationally recognized certification scheme.

7.2.2 Generally, operators subject to direct supervision are to be qualified to Level I, unsupervised personnel to Level II and more senior personnel to Level III.

7.2.3 Qualification schemes are to include assessments of practical ability for Levels I and II individuals; these examinations to be made on representative test pieces containing relevant defects.

7.3 Extent of NDE

7.3.1 For Class 1 pressure vessels:

(a) All butt welded seams in drums, shells, headers and test plates, together with tubes or nozzles over 170 mm outside diameter are subject to 100 per cent volumetric and surface crack detection inspections.

(b) For circumferential butt welds in extruded connections, tubes, headers and other tubular parts of 170 mm outside diameter or less, at least 10 per cent of the total number of welds is to be subjected to volumetric examination and surface crack detection inspections.

7.3.2 For Class 2/1 pressure vessels, volumetric and surface crack detection inspections are to be applied at selected regions of each main seam. At least 10 per cent of each main seam is to be examined together with the full length of each welded test plate. When an unacceptable indication is detected, at least two additional check points in the seam are to be selected by the Surveyor for examination using the same inspection method. If further unacceptable defects are found then either:

(a) the whole length of weld represented is to be cut out and re-welded and re-examined as if it was a new weld with the test plates being similarly treated; or

(b) the whole length of the weld represented is to be re-examined using the same inspection methods.

7.3.3 Butt welds in Class 1 pipes of 75 mm or more outside diameter are subject to 100 per cent volumetric and surface crack detection inspections. The extent and method of testing applied to butt welds in Class 1 pipes of less than 75 mm outside diameter is at the Surveyor's discretion.

7.3.4 The extent of testing to be applied to butt welds or fillet welds in Class II pipes of 100 mm or more outside diameter is at the Surveyor's discretion.

7.3.5 NDE is not required for Class II pipes less than 100 mm outside diameter.

7.3.6 Butt welds in furnaces, combustion chambers and other pressure parts for fired pressure vessels under external pressure are to be subject to spot volumetric examination, the minimum length of each check point being 300 mm.

7.4 Procedures

7.4.1 Non-Destructive Examinations are to be made in accordance with a definitive written procedure prepared in accordance with a nationally recognized standard and endorsed by a Level III individual. As a minimum, the procedure will identify personnel qualification levels, NDE datum and identification system, extent of testing, methods to be applied with technique sheets, acceptance criteria and reporting requirements.

7.5 Method

7.5.1 Volumetric examinations may be made by radiography or, in the case of welds of nominal thickness 15 mm or above, by ultrasonic testing. The preferred method for surface crack detection in ferrous metals is magnetic particle inspection, and that for non-magnetic materials is liquid penetrant inspection.

~~**7.6 Repairs**~~

7.6.1 Unacceptable defects are to be repaired and re-examined using the NDE methods originally applied.

7.7 Evaluation and reports

7.7.1 The manufacturer shall be responsible for the review, interpretation, evaluation and acceptance of the results of NDE. Reports stating compliance or otherwise with the criteria established in the inspection procedure are to be issued. Reports are to include the following information where appropriate:

(a) date of inspection;
(b) names, qualifications and signatures of operator and supervisor;
(c) component identification;
(d) location and extent of testing;
(e) heat treatment status;
(f) weld type, procedure and configuration;
(g) surface condition;
(h) inspection procedure reference;
(j) equipment used;
(k) results showing size, position and nature of any defects repaired; and
~~(l) statement of final acceptability to established criteria.~~

Volume 2, Part 2, Chapter 1

Diesel Engines

Effective date 1 January 2009

■ *Section 5* Construction and welded structures

5.3 Materials and construction

5.3.1 All welded construction is to be in accordance with the requirements specified in Chapter 13 of the Rules for Materials.

Existing paragraph 5.3.1 is to be renumbered 5.3.2.

■ *Section 9* Control and monitoring

9.3 Electrical generator and auxiliary engine speed governors

9.3.4 Emergency generator engines are to comply with 9.3.1 except that the initial load required by 9.3.1(b) is to be not less than the total connected emergency load~~.~~ , or if their total consumer load is applied in steps, the following requirements are to be met:

(a) the total load is supplied within 45 seconds from power failure on the main switchboard;
(b) the maximum step load is declared and demonstrated; and
(c) the power distribution system is designed such that the declared maximum step loading is not exceeded.

9.3.5 Compliance of time delays and loading sequence with the requirements of 9.3.4 is to be demonstrated at ship's trials.

Existing paragraphs 9.3.5 to 9.3.8 are to be renumbered 9.3.6 to 9.3.9.

CORRIGENDA

9.7 Diesel engines for propulsion purposes

(Part only shown)

Table 1.9.2 Auxiliary diesel engines: Alarms and shutdowns

Item	Alarm	Note
Lubricating oil inlet temperature	High	—
Lubricating oil inlet pressure	1st stage low	—
	2nd stage low	Automatic shutdown of engine~~,~~ *see* 9.6.2
Oil mist concentration in crankcase or bearing temperature	High	Automatic shutdown of engine, *see* 9.1.2
Oil fuel high pressure piping*	Leakage	See 9.1.2
Coolant outlet temperature (for engines >220 kW)	1st stage high	—
	2nd stage high	Automatic shutdown of engine~~,~~ *see* 9.6.3
Coolant pressure or flow	Low	—
Oil fuel temperature or viscosity	High and Low	Heavy oil only
Overspeed	High	*See* 9.4
Starting air pressure	Low	—
Electrical starting battery charge level	Low	—
Exhaust gas temperature	High	Per cylinder. For engine power <500 kW/cylinder, common sensors for each inlet to the turbocharger may be accepted. ~~See Note~~

NOTE
The arrangements are to comply with the requirements of the Naval Authority concerned.

Section 10
Alarms and safeguards for emergency diesel engines

10.1 General

(Part only shown)

Table 1.10.1 Alarms and safeguards for emergency diesel engines

Effective date 1 January 2009

Section 13
Type testing procedure for crankcase explosion relief valves

13.1 Scope

13.1.1 To specify type tests and identify standard test conditions using methane gas and air mixture to demonstrate that ~~This test procedure has been developed to identify standard conditions by which~~ LR requirements are satisfied for crankcase explosion relief valves intended to be fitted to ~~diesel~~ engines and gear cases ~~can be tested to demonstrate that they satisfy LR requirements for type testing to a defined standard~~.

~~*13.1.2* This test procedure is also applicable to explosion relief valves intended for gear cases.~~

~~*13.1.3* Standard repeatable test conditions have been established using methane gas and air mixture.~~

~~*13.1.4*~~ *13.1.2* The test procedure is only applicable to explosion relief valves fitted with flame arresters. Where internal oil wetting of a flame arrester is a design feature of an explosion relief valve, alternative testing arrangements that demonstrate compliance with these requirements may be proposed by the manufacturer. The alternative testing arrangements are to be submitted to LR for approval.

13.4 Test facilities

13.4.1 ~~The test facilities for~~ Test Houses carrying out type testing of crankcase explosion relief valves are to meet the following criteria:

(a) The test ~~facilities~~ houses where testing is carried out are to be accredited to a National or International Standard for the testing of explosion protection devices, such as ISO/IEC 17025.
(b) The test facilities are to be acceptable to LR.
(c) The test facilities are to be equipped so that they can ~~control~~ perform and record explosion testing in accordance with this procedure.
(d) The test facilities are to have equipment for controlling and measuring a methane gas in air concentration within a test vessel to an accuracy of ± 0,1 per cent.
(e) The test facilities are to be capable of effective point located ignition of methane gas in air mixture.

(f) The pressure measuring equipment is to be capable of measuring the pressure in the test vessel in at least two positions. One at the valve and the other at the test vessel centre. The measuring arrangements are to be capable of measuring and recording the pressure changes throughout an explosion test at a frequency recognising the speed of events during an explosion. The result of each test is to be documented by video recording and ~~if necessary~~ by recording with a heat sensitive camera.

(g) The test vessel for explosion testing is to have documented dimensions ~~that are to be such that its height or length between dished ends is approximately 2 times its diameter but not more than 2,5 times~~ .The dimensions are to be such that the vessel is not pipe-like with the distance between dished ends being not more than 2,5 times the diameter. The internal volume of the test vessel is to ~~be determined from the vessel dimensions that~~ include any standpipe arrangements.

(h) The test vessel ~~for explosion testing~~ is to be provided with a flange, located centrally at one end at 90 degrees to the vessel longitudinal axis for mounting the explosion relief valve. The test vessel is to be arranged in an orientation consistent with how the valve ~~it~~ will be installed in service, i.e., in the vertical plane or the horizontal plane. ~~The flange arrangement is to be made approximately one third of the height or length of the test vessel.~~

(j) A circular flat plate ~~having the following dimensions~~ is to be provided for fitting between the pressure vessel flange and valve to be tested with the following dimensions:

- (i) Outside diameter ~~= 2 x *D* where *D* is~~ of 2 times the outer diameter of the valve top cover. ~~The circular plate is to provide simulation of the crankcase surface.~~
- (ii) Internal bore having the same internal diameter of the valve to be tested.

(k) The test vessel ~~for explosion testing~~ is to have connections for measuring the methane in air mixture ~~in~~ at ~~least two positions, i.e.,~~ the top and bottom.

(l) The test vessel ~~for explosion testing~~ is to be provided with a means of fitting an ignition source at a position ~~approximately one third the height or length of the vessel~~ as specified in 13.5.3.

(m) The test vessel volume is to be as far as practicable, related to the size and capability of the relief valve to be tested. In general, the volume is to correspond to the requirement in 6.3.1 for the free area of explosion relief valve to be not less than 115 cm^2/m^3 of crankcase gross volume, i.e., the testing of a valve having 1150 cm^2 of free area, would require a test vessel with a volume of 10 m^3. ~~In any case the volume of the test vessel is not to vary by more than +15 to −10 per cent from the 115 cm²/m³ volume ratio.~~ The following is to apply:

- (i) Where the free area of relief valves is greater than 115 cm^2/m^3 of the crankcase gross volume, the volume of the test vessel is to be consistent with the design ratio.
- (ii) In no case is the volume of the test vessel to vary by more than ± 15 per cent from the design cm^2/m^3 volume ratio.

13.5 Explosion test process

13.5.1 All explosion tests to verify the functionality of crankcase explosion relief valves are to be carried out using an air and methane mixture with a volumetric methane concentration of 9,5 per cent ±0,5 per cent. The pressure in the test vessel is to be not less than atmospheric and is not to exceed ~~0.2 bar~~ the opening pressure of the relief valve.

13.5.3 The ignition of the methane and air mixture is to be made at the centreline of the test vessel at a position approximately one third of the height or length of the test vessel opposite to where the valve is mounted.

13.5.4 The ignition is to be made using a maximum 100 joule explosive charge.

13.6 Valves to be tested

13.6.1 The valves used for type testing (including the testing specified in 13.6.3) are to be ~~manufactured and tested in accordance with procedures acceptable to LR and~~ selected from the manufacturer's ~~usual~~ normal production line for such valves by the LR Surveyor witnessing the tests.

13.6.2 For approval of a specific valve size, three valves of that specific size are to be tested in accordance with 13.6.3 and 13.7. For a series of valves, *see* 13.9. ~~The valves are to have been tested at the manufacturer's works to demonstrate that the opening pressure is 0,05 bar ± 20 per cent and that the valve is air tight at a pressure below the opening pressure for at least 30 seconds.~~

13.6.3 The valves selected for type testing are to have been previously tested at the manufacturer's works to demonstrate that the opening pressure is in accordance with the specification within a tolerance of ± 20 per cent and that the valve is air tight at a pressure below the opening pressure for at least 30 seconds. This test is to verify that the valve is air tight following assembly at the manufacturer's works and that the valve begins to open at the required pressure demonstrating that the correct spring has been fitted.

~~*13.6.3*~~ *13.6.4* The ~~selection~~ type testing of valves ~~for type testing~~ is to recognise the orientation that they are intended to be installed on the engine or gear case. ~~Where it is intended that valves be installed in the vertical or near vertical or the horizontal or near horizontal position, then t~~ Three valves of each size are to be tested for each intended installation orientation, i.e. in the vertical and/or horizontal positions .

13.7 Method

13.7.1 The following requirements are to be satisfied at explosion testing:

(a) The explosion testing is to be witnessed by a LR Surveyor~~ where type testing approval is required by LR~~.

~~(b)~~ ~~Valves are to be tested in the vertical or horizontal position consistent with the orientation in which they are intended to be installed on an engine or gear case, usually in the vertical position, *see* 13.6.3.~~

~~(c)~~(b) Where valves are to be installed on an engine or gear case with shielding arrangements to deflect the emission of explosion combustion products, the valves are to be tested with the shielding arrangements fitted.

~~(d)~~ ~~Type testing is to be carried out for each range of valves that a manufacturer requires LR approval.~~

~~(e)~~(c) Successive explosion testing to establish a valve's functionality is to be carried out as quickly as possible during stable weather conditions.

~~(f)~~(d) The pressure rise and decay during all explosion testing is to be recorded.

~~(g)~~(e) The external condition of the valves is to be monitored during each test for indication of any flame release by video and heat sensitive camera.~~ The test facility is to produce a report on the explosion test findings.~~

13.7.3 Stage 1:
Two explosion tests are to be carried out in the test vessel ~~with the flange opening fitted~~ with the circular plate as specified in 13.4.1(j) fitted and the opening in the plate covered by a 0,05 mm thick polythene film. These tests establish a reference pressure level for determination of the ~~effects~~ capability of a relief valve in terms of pressure rise in the test vessel, *see* 13.8.1(f).

(Part only shown)
13.7.4 Stage 2:

(b) The first of the two tests on each valve is to be carried out with a 0,05 mm thick polythene bag having a minimum diameter of three times the diameter of the circular plate and volume not less than 30 per cent of the test vessel enclosing the valve and circular plate. Before carrying out the explosion test the polythene bag is to be empty of air. The ~~plastic~~ polythene bag is required to provide a readily visible means of assessing whether there is flame transmission through the relief valve following an explosion consistent with the requirements of the standards identified in 13.2. During the test, the explosion pressure will open the valve and some unburned methane/air mixture will be collected in the polythene bag. When the flame reaches the flame arrester and if there is flame transmission through the flame arrester, the methane/air mixture in the bag will be ignited and this will be visible.

(c) Provided that the first explosion test successfully demonstrated that there was no indication of combustion outside the flame arrester and there are no signs of damage to the flame arrester or valve, a second explosion test without the polythene bag arrangement is to be carried out as quickly as possible after the first test. During the second explosion test, the valve is to be visually monitored for any indication of combustion outside the flame arrester and video records are to be kept for subsequent analysis. The second test is required to demonstrate that the valve can function in the event of a secondary crankcase explosion.

13.8 Assessment and records

13.8.1 ~~Assessment of the valves after~~ For the purposes of verifying compliance with the requirements of this Section, the assessment and records of the valves used for explosion testing is to address the following points:

(a) The valves to be tested are to have evidence of appraisal/approval by LR, *see also* 13.6.1.

(b) The designation, dimensions and characteristics of the valves to be tested are to be recorded. This is to include the ~~valve~~ free area of the valve and of the flame arrester and the amount of valve lift at 0,2 bar.

(c) The test vessel volume is to be determined and recorded.

(d) For acceptance of the functioning of the flame arrester there is not to be any indication of flame or combustion outside the valve during an explosion test.

(e) The pressure rise and decay during an explosion is to be recorded with indication of the pressure variation showing the maximum over-pressure and steady under pressure in the test vessel during testing. The pressure variation is to be recorded at two points in the pressure vessel.

(f) The effect of an explosion relief valve in terms of pressure rise following an explosion is ascertained from maximum pressures recorded at the centre of the test vessel during the three stages. The pressure rise within the test vessel due to the installation of a relief valve is the difference between average pressure of the four explosions from Stages 1 and 3 and the average of the first tests on the three valves in Stage 2. The pressure rise is not to exceed the limit specified by the manufacturer.

(g) The valve tightness is to be ascertained by verifying from the records at the time of testing that an under-pressure of at least 0,3 bar is held by the test vessel for at least 10 seconds following an explosion. This test is to verify that the valve has effectively closed and is reasonably gas-tight following dynamic operation during an explosion.

(h) After each explosion test in Stage 2, the external condition of the flame arrester is to be examined for signs of serious damage and/or deformation that may affect the operation of the valve.

(j) After completing the explosion tests, the valves are to be dismantled and the condition of all components ascertained and documented. In particular, any indication of valve sticking or uneven opening that may affect the operation of the valve is to be noted. Photographic records of the valve condition are to be taken and included in the report.

13.9 Design series qualification

13.9.2 The quenching ability of a flame ~~screen~~ arrester depends on the total mass of quenching lamellas/mesh. Provided the materials, thickness of materials, length ~~depth~~ of lamellas/thickness of mesh layer and the quenching gaps are the same, then the same quenching ability can be qualified for different sizes of flame ~~screen~~ arresters. This is subject to (a) and (b) being satisfied.

(a) $\frac{n_1}{n_2} = \sqrt{\frac{S_1}{S_2}}$

(b) $\frac{A_1}{A_2} = \frac{S_1}{S_2}$

where

n_1 = total depth of flame arrester corresponding to the number of lamellas of size 1 quenching device for a valve with a relief area equal to S_1

n_2 = total depth of flame arrester corresponding to the number of lamellas of size 2 quenching device for a valve with a relief area equal to S_2

A_1 = free area of quenching device for a valve with a relief area equal to S_1

A_2 = free area of quenching device for a valve with a relief area equal to S_2

13.9.3 The qualification of explosion relief valves of larger sizes than that which has been previously satisfactorily tested in accordance with 13.7 and 13.8 can be evaluated where valves are of identical type and have identical features of construction subject to the following:

(a The free area of a larger valve does not exceed three times ± 5 per cent that of the valve that has been satisfactorily tested.

(b) One valve of the largest size, subject to (a), requiring qualification is subject to satisfactory testing required by 13.6.3 and 13.7.4 except that a single valve will be accepted in 13.7.4(a) and the volume of the test vessel is not to be less than one third of the volume required by 13.4.1(m).

(c) The assessment and records are to be in accordance with 13.8, noting that 13.8.1(f) will only be applicable to Stage 2 for a single valve.

13.9.4 The qualification of explosion relief valves of smaller sizes than that which has been previously satisfactorily tested in accordance with 13.7 and 13.8 can be evaluated where valves are of identical type and have identical features of construction subject to the following:

(a) The free area of a smaller valve is not less than one third of that of the valve that has been satisfactorily tested.

(b) One valve of the smallest size, subject to (a), requiring qualification is subject to satisfactory testing required by 13.6.3 and 13.7.4 except that a single valve will be accepted in 13.7.4(a) and the volume of the test vessel is not to be more than the volume required by 13.4.1(m).

(c) The assessment and records are to be in accordance with 13.8, noting that 13.8.1(f) will only be applicable to Stage 2 for a single valve.

13.10 The report

(Part only shown)

13.10.1 The test ~~facility~~ house is to deliver a full report that includes the following information and documents:

(h) The assessment and records stated in 13.8

13.11 Approval

13.11.1 The approval ~~Approval~~ of an explosion relief valve is at the ~~prerogative~~ discretion of LR, based on the appraisal of plans and particulars and the test ~~facilities~~ faclilty's report of the results of type testing.

■ *Section 14*
Type testing procedure for crankcase oil mist detection/ monitoring and alarm arrangements

14.1 Scope

14.1.1 ~~This test procedure has been developed to identify standard conditions by which crankcase oil mist detection/ monitoring and alarm equipment and systems intended to be fitted to diesel engines can be tested to demonstrate that they satisfy LR requirements for type testing to a defined standard.~~ To specify the tests required to demonstrate that crankcase oil mist detection and alarm equipment intended to be fitted to diesel engines satisfy LR requirements.

14.1.2 This test procedure is also applicable to oil mist detection~~/monitoring~~ and alarm arrangements intended for gear cases.

14.3 Purpose

(Part only shown)

14.3.1 The purpose of type testing crankcase oil mist detection~~/monitoring~~ and alarm ~~arrangements~~ equipment is ~~sevenfold~~ seven fold:

(e) To verify time delays between oil mist leaving the source ~~extraction from crankcase~~ and alarm activation.

(f) To verify ~~the operation of alarms to indicate~~ functional failure ~~in the equipment and associated arrangements~~ detetction.

(g) To verify ~~that there is an indication of lens obscuration to a level that will affect the reliability of information and alarms~~ the influence of optical obscuration on detection.

14.4 Test facilities

14.4.1 ~~The test~~ Test houses carrying out type testing of crankcase ~~oil mist~~ detection~~/monitoring~~ and alarm equipment ~~and arrangements~~ are to satisfy the following criteria:

(a) ~~The test facilities are to have the full range of facilities for carrying the type and functionality tests required by this procedure~~ A full range of facilities for carrying out the environmental and functionality tests required by this procedure shall be available and be acceptable to LR.

(b) The test ~~facilities~~ house that ~~verify~~ verifies that the functionality of the equipment ~~ascertains the levels of oil mist concentration~~ are to be equipped so that ~~they~~ it can control, measure and record oil mist concentration levels in terms of mg/l to an accuracy of ± 10 per cent accordance with this procedure.

~~(c)~~ ~~The type tests are to be witnessed by a LR Surveyor unless otherwise agreed.~~

~~(d)~~ ~~The oil mist concentrations are to be ascertained by the gravimetric deterministic method or equivalent. The gravimetric deterministic method is a laboratory process where the difference in weight of a milipore (typically 0,8 m) filter is ascertained from weighing the filter before and after drawing 1m^3 of oil mist through the filter.~~

~~(e)~~ ~~The results of a gravimetric analysis are considered invalid and are to be rejected if the resultant calibration curve has an increasing gradient with respect to the oil mist detection/monitoring reading. This situation occurs when insufficient time has been allowed for the oil mist to become homogeneous. Single results that are more than 10 per cent below the calibration curve are to be rejected. This situation occurs when the integrity of the filter unit has been compromised and not all of the oil is collected on the filter paper.~~

~~(f)~~ ~~The filters require to be weighed to a precision of 0,1 mg and the volume of air/oil mist sampled to 10 ml.~~

14.5 Equipment testing

14.5.2 The range of tests is to include the following for the detectors:

(a) Functional tests described in 14.6.
(b) Electrical power supply failure test.
(c) Power supply variation test.
(d) Dry heat test.
(e) Damp heat test.
(f) Vibration test.
(g) EMC test where susceptible.
~~(g)~~(h) Insulation resistance test.
~~(h)~~(j) High voltage test.
~~(i)~~(k) Static and dynamic inclinations~~, if moving parts are contained~~.

14.6 Functional test ~~process~~

14.6.1 All tests to verify the functionality of crankcase oil mist detection~~/monitoring devices~~ and alarm equipment are to be carried out in accordance with 14.6.2 to ~~14.6.6~~ 14.6.8 with an oil mist concentration in air, known in terms of mg/l to an accuracy of ±10 per cent.

14.6.2 The concentration of oil mist in the test ~~vessel~~ chamber is to be measured in the top and bottom of the ~~vessel~~ chamber and is not to differ by more than 10 per cent.

14.6.3 The oil mist monitoring arrangements are to be capable of detecting oil mist in air concentrations of between 0 and 10 per cent of the lower explosive limit (LEL)~~.~~

~~NOTE~~

~~The LEL~~ , which corresponds to an oil mist concentration of approximately 50 mg/l (13 per cent oil-air mixture) or between 0 and a percentage corresponding to a level not less than twice the maximum oil mist concentration alarm set point.

14.6.4 The ~~operation of the~~ alarm set point ~~indicators~~ for oil mist concentration in air ~~are to be verified and are~~ is to provide an alarm at a maximum setting corresponding to not more than 5 per cent of the LEL corresponding to approximately 2,5 mg/l.

14.6.5 Where alarm set points can be altered, the means of adjustment and indication of set points are to be verified against the equipment manufacturer's instructions.

14.6.6 Where oil mist is drawn into a detector~~/monitor~~ via piping arrangements, the time delay between the sample leaving the crankcase and operation of the alarm is to be determined for the longest and shortest lengths of pipes recommended by the manufacturer. The pipe arrangements are to be in accordance with the manufacturer's instructions/recommendations.

14.6.7 Detector equipment that is in contact with the crankcase atmosphere and may be exposed to oil splash and spray from engine lubricating oil is to be tested to demonstrate that openings do not occlude or become blocked under continuous oil splash or spray conditions. Testing is to be in accordance with arrangements proposed by the manufacturer and agreed by LR.

14.6.8 Detector equipment may be exposed to water vapour from the crankcase atmosphere which may affect the sensitivity of the equipment, it is to be demonstrated that exposure to such conditions will not affect the functional operation of the detector equipment. Where exposure to water vapour and/or water condensation has been identified as a possible source of equipment malfunctioning, testing is to demonstrate that any mitigating arrangements such as heating are effective. Testing is to be in accordance with arrangements proposed by the manufacturer and agreed by LR. This testing is in addition to that required by 14.5.2(e) and is concerned with the effects of condensation caused by the detection equipment being at a lower temperature than the crankcase atmosphere.

14.7 Detectors~~/monitors~~ and alarm equipment to be tested

14.7.1 The detectors~~/monitors~~ and alarm equipment ~~used in~~ selected for the type testing are to be ~~manufactured and tested in accordance with procedures acceptable to LR and~~ selected from the manufacturer's ~~usual~~ normal production line ~~for such equipment~~ by the LR Surveyor witnessing the tests.

14.7.2 Two ~~sets of~~ detectors~~/monitors requiring approval~~ are to be tested. One ~~set~~ is to be tested in the clean condition and the other in a condition ~~that represents~~ representing the maximum ~~degree~~ level of lens obscuration ~~that is stated as being acceptable~~ specified by the manufacturer.

14.8 Method

14.8.1 The ~~following~~ requirements of 14.8 are to be satisfied at type testing~~:~~ .

~~(a) The testing is to be witnessed by a LR Surveyor where type testing approval is required by LR.~~
~~(b) Oil mist detection/monitoring devices are to be tested in the orientation in which they are intended to be installed on an engine or gear case.~~
~~(c) Type testing is to be carried out for each range of oil mist detection/monitoring devices that a manufacturer requires LR approval.~~
~~(d) The test house is to produce a test report.~~

14.8.2 Oil mist generation is to satisfy the following:

(a) Oil mist is to be generated with suitable equipment using an SAE 80 monograde mineral oil or equivalent and supplied to a test chamber having a volume of not less than 1 m^3. The oil mist produced is to have a maximum droplet size of 5 μm. The oil droplet size is to be checked using the sedimentation method.
(b) The oil mist concentrations used are to be ascertained by the gravimetric deterministic method or equivalent. For this test, the gravimetric deterministic method is a process where the difference in weight of a 0.8 μm pore size membrane filter is ascertained from weighing the filter before and after drawing 1 litre of oil mist through the filter from the oil mist test chamber. The oil mist chamber is to be fitted with a recirculating fan.
(c) Samples of oil mist are to be taken at regular intervals and the results plotted against the oil mist detector output. The oil mist detector is to be located adjacent to where the oil mist samples are drawn off.
(d) The results of a gravimetric analysis are considered invalid and are to be rejected if the resultant calibration curve has an increasing gradient with respect to the oil mist detection reading. This situation occurs when insufficient time has been allowed for the oil mist to become homogeneous. Single results that are more than 10 per cent below the calibration curve are to be rejected. This situation occurs when the integrity of the filter unit has been compromised and not all of the oil is collected on the filter paper.
(e) The filters require to be weighed to a precision of 0.1 mg and the volume of air/oil mist sampled to 10 ml.

14.8.3 The testing is to be witnessed by an LR Surveyor where type testing approval is required by LR.

14.8.4 Oil mist detection equipment is to be tested in the orientation (vertical, horizontal or inclined) in which it is intended to be installed on an engine or gear case as specified by the equipment manufacturer.

14.8.5 Type testing is to be carried out for each type of oil mist detection and alarm equipment for which a manufacturer seeks LR approval. Where sensitivity levels can be adjusted, testing is to be carried out at the extreme and mid-point level settings.

14.9 Assessment

14.9.1 Assessment of oil mist detection~~/monitoring devices~~ equipment after testing is to address the following points:

(a) The ~~devices~~ equipment to be tested ~~are~~ is to have evidence of design appraisal/approval by LR, *see also* 14.7.1.
(b) ~~The d~~Details of the detection~~/monitoring devices~~ equipment to be tested are to be recorded~~.~~ , ~~This is to include~~ such as name of manufacturer, type designation, oil mist concentration assessment capability and alarm settings.
(c) After completing the tests, the detection~~/monitoring devices are~~ equipment is to be examined and the condition of all components ascertained and documented. Photographic records of the monitoring ~~devices~~ equipment condition are to be taken and included in the report.

14.10 Design series qualification

14.10.1 The approval of one type of detection~~/monitoring device~~ equipment may be used to qualify other devices having identical construction details. Proposals are to be submitted for consideration.

14.11 The ~~R~~report

14.11.1 The test house is to provide a full report that includes the following information and documents:

(a) Test specification.
(b) Details of ~~devices~~ equipment tested.
(c) Results of tests.

14.12 Acceptance

14.12.1 Acceptance of crankcase oil mist detection~~/monitoring devices is the prerogative~~ equipment is at the discretion of LR based on the appraisal plans and particulars and the test ~~facilities~~ house report of the results of type testing.

14.12.2 The following information is to be submitted to LR for acceptance of oil mist detection~~/monitoring~~ equipment and alarm arrangements:

(a) Description of oil mist detection~~/monitoring~~ equipment and system including alarms.
(b) Copy of the test house report identified in 14.11.
(c) Schematic layout of engine oil mist detection~~/monitoring~~ arrangements showing location of detectors/sensors and piping arrangements and dimensions.
(d) Maintenance and test manual which is to include the following information:
- Intended use of equipment and its operation.
- Functionality tests to demonstrate that the equipment is operational and that any faults can be identified and corrective actions notified.
- Maintenance routines and spare parts recommendations.
- Limit setting and instructions for safe limit levels.
- Where necessary, details of configurations in which the equipment is and is not to be used.

Volume 2, Part 2, Chapter 2
Gas Turbines

CORRIGENDA

■ *Section 1*
General requirements

1.4 Gas turbine type approval

1.4.1 New gas turbine types or developments of existing types are to be type approved in accordance with Lloyd's Register's (hereinafter referred to as 'LR') *Type Approval System Procedure – Test Specification ~~GT98~~ GT04*.

Effective date 1 January 2009

■ *Section 4*
Design and construction

4.9 Welded construction

4.9.1 ~~Full strength welds are to be used for all major joints and be designed so as to ensure complete fusion of the joint.~~ Welding is to be carried out in accordance with the requirements of Chapter 13 of the Rules for Materials, using welding procedures and welders that have been qualified in accordance with Chapter 12 of the Rules for Materials.

Volume 2, Part 2, Chapter 3
Steam Turbines

Effective date 1 January 2009

■ *Section 4*
Design and construction

4.2 Welded components

4.2.2 Welding is to be carried out in accordance with the requirements of Ch 13, 4 of the Rules for Materials using welding procedures and welders that have been qualified in accordance with Chapter 12 of the Rules for Materials.

Existing paragraphs 4.2.2 to 4.2.7 are to be renumbered 4.2.3 to 4.2.8.

~~*4.2.8* The heat treatment of welded rotors is to be carried out as approved.~~

4.2.9 ~~Surveyors are to be satisfied that the desired quality of welding is attainable with the proposed welding equipment and procedure, and for this purpose, test specimens representative of the welded joints are to be provided for radiographic examination and mechanical tests.~~ For all welded components, weld procedure tests are to be in accordance with Ch 12, 2.7 of the Rules for Materials.

~~*4.2.10* For cylinders, the mechanical tests of butt joints are to include tensile, bend and macro tests as detailed in Pt 1, Ch 3.~~

~~*4.2.11* For diaphragms, nozzle plates, etc., representative samples are to be sectioned and macro-etched.~~

~~*4.2.12* For rotors, the mechanical tests are to include tensile (all weld metal), tensile (joint), bend (transverse), bend (longitudinal) and macro tests as detailed in Pt 1, Ch 3, or such other tests as may be approved.~~

~~*4.2.13*~~ *4.2.10* ~~In subsequent production, check tests of the quality of the welding are to be carried out at the discretion of the Surveyors.~~ Production weld tests are to be performed according to the requirements of Ch 13, 4.5 of the Rules for Materials.

Volume 2, Part 3, Chapter 2
Shafting Systems

Effective date 1 January 2009

■ *Section 4* Design and construction

4.7 Coupling bolts

4.7.3 Where dowels or expansion bolts are fitted to transmit torque in shear they are to comply with the requirements of 4.7.1. The expansion bolts are to be installed, and the bolt holes in the flanges are to be correctly aligned, in accordance with manufacturer's instructions.

~~*4.7.3*~~ *4.7.4* The minimum diameter of tap bolts or of bolts in clearance holes at the joining faces of coupling flanges, pretensioned to 70 per cent of the bolt material yield strength value, is not to be less than:

$$d_R = 1{,}348 \sqrt{\left(\frac{120\ 10^6\ F\ P\ (1+C)}{R\ D} + Q\right)\frac{1}{n\ \sigma_y}}$$

where d_R is taken as the lesser of:

(a) Mean of effective (pitch) and minor diameters of the threads.

(b) Bolt shank diameter away from threads. (Not for waisted bolts which will be specially considered.)

F = 2,5 where the flange connection is not accessible from within the ~~craft~~ ship
= 2,0 where the flange connection is accessible from within the ~~craft~~ ship

C = ratio of vibratory/mean torque values at the rotational speed being considered

D = pitch circle diameter of bolt holes, in mm

Q = external load on bolt in N (+ve tensile load tending to separate flange, –ve)

n = number of tap or clearance bolts

σ_y = bolt material yield stress in N/mm^2.

~~*4.7.4*~~ *4.7.5* Consideration will be given to those arrangements where the bolts are pretensioned to loads other than 70 per cent of the material yield strength.

4.7.6 Where clamp bolts are fitted they are to comply with the requirements of 4.7.4 and are to be installed, and the bolt holes in the flanges correctly aligned, in accordance with manufacturer's instructions.

Volume 2, Part 4, Chapter 2
Water Jet Systems

CORRIGENDA

■ *Section 7* Electrical systems

7.1 Distribution arrangements

7.1.1 Water jet auxiliaries and controls are to be served by individual circuits. Services that are duplicated are to be separated throughout their length as widely as is practicable and without the use of common feeders, transformers, ~~convertors~~ converters, protective devices or control circuits.

Volume 2, Part 4, Chapter 3
Water Jet Systems

CORRIGENDA

■ *Section 7* Electrical systems

7.3 Distribution arrangements

7.3.1 Azimuth thruster auxiliaries and controls are to be served by individual circuits. Services that are duplicated are to be separated throughout their length as widely as is practicable and without the use of common feeders, transformers, ~~convertors~~ converters, protective devices or control circuits.

7.4 Auxiliary supplies

(Part only shown)
7.4.1
(b) auxiliary equipment and services are to operate with any waveform distortion introduced by ~~convertors~~ converters without deleterious effect. (This may be achieved by the provision of suitably filtered/converted supplies).

Volume 2, Part 4, Chapter 4
Podded Propulsion Units

Effective date 1 January 2009

■ *Section 1* Scope

1.1 Application

1.1.8 The design of a podded propulsor system is to take into account a range of operating conditions which are to include the following:
- All ahead seagoing conditions up to and including the maximum rated output of the podded propulsor while maintaining a steady course under foreseeable operating, sea and wind conditions and in cases where directional instability may occur.
- The ability of the ship to change direction rapidly at the declared steering angles with the ship running at maximum ahead service speed.
- Executing a steady turning manoeuvre with a tactical diameter not greater than 5*L* and advance not greater than 4,5*L* whilst maintaining a power corresponding to the test speed, where *L* is the length measured between the aft and forward perpendiculars. Test speed is defined as a speed of at least 90 per cent of the ship's speed corresponding to 85 per cent of the maximum rated power of the podded propulsor.
- Changing heading, manoeuvring in and out of harbour both ahead and astern, at slow speeds, stationary and starting from rest in foreseeable current and wind conditions.
- Berthing manoeuvres in the case of azimuthing podded propulsion units.
- Rapid acceleration and deceleration manoeuvres where the ship's operating profile demands this capability.
- Holding stationary positions over-ground under different conditions.
- Stopping manoeuvre as required by Pt 10, Ch 1, 20.2.
- Manoeuvring in ice where ice class is required.

■ *Section 2* General requirements

2.2 Plans and information to be submitted

(Part only shown)
2.2.1 In addition to the plans required by Pt 3, Ch 1 and Ch 2, Pt 4, Ch 1, Pt 5, Pt 6, Ch 1, Pt 7, Ch 3 and Parts 9 and 10, the following plans and information are required to be submitted for appraisal:

(j) Supporting data~~, calculations~~ and direct calculation reports. This is to include, where applicable an assessment of anticipated global accelerations acting on the ship's machinery and equipment which may potentially affect the reliable operation of the propulsion system for all foreseeable seagoing and operating conditions. Typically, this may include response to slamming, extreme ship motions and pod interaction. *See also* 1.1.5.

(l) ~~Nozzle ring structure and nozzle support details if applicable to the application.~~ Nozzle structure, its support arrangements, together with related calculations for all foreseeable operating and seagoing conditions where the propeller operates in a nozzle (duct), *see* Vol 1, Pt 3, Ch 3, Section 5.

~~(u)~~ ~~Recommended installation, inspection, maintenance and component replacement procedures (*see also* 5.1.2). This is to include any in-water/underwater engineering procedures where recommended by the pod manufacturer. *See also* 6.5.7 and Section 10.~~

Existing paragraphs (v) to (z) are to be renumbered (u) to (y).

~~(w)~~ (v) Where provided, ~~A~~ access and closing arrangements for pod unit inspection and maintenance.

2.2.3 Recommended installation, inspection, maintenance and component replacement procedures (*see* also 5.1.2). This is to include any in-water/underwater engineering procedures where recommended by the pod manufacturer. *See also* 6.5.7 and Section 10.

2.4 Global loads

2.4.2 ~~Where the maximum loads and moments described in 2.4.1 cannot be readily identified from calculation methods or are based on model testing, the estimated loads and moments are to be stated at pod unit steering angular intervals of 5 degrees over the range from ahead to astern for the relevant combinations of shaft rotational and ship speed.~~ Where the maximum forces and moments defined in 2.4.1 cannot be accurately calculated, then, an estimate of these loadings is to be stated together with an assessment of the associated error tolerances for the sequences of permitted design manoeuvres (*see* 1.1.8). Typically this will include emergency astern manoeuvres, zig zag manoeuvres and pod interaction. Such estimates are to be defined on a load versus pod angle basis. In the case of pod to pod and/or pod to ship hydrodynamic interaction effects, these must be defined for the most severely affected propulsor including cases where pod units are capable of being independently steered.

2.4.5 The podded propulsor is to be capable of withstanding a blade root failure due to fatigue occurring at the maximum rated output of the podded propulsor without initiating a failure in other parts of the propulsor system. After a blade failure, the podded propulsor is to be capable of reduced power operation in accordance with the manufacturer's instructions.

■ *Section 5* Structure design and construction requirements

5.1 Pod structure

5.1.2 Means are to be provided to enable the propeller shaft, bearings and seal arrangements to be ~~fully~~ examined in accordance with LR's requirements and the manufacturer's recommendations ~~at docking Survey to the Surveyor's satisfaction~~.

5.1.6 For fabricated structures, v~~V~~ertical and horizontal plate diaphragms are to be arranged within the strut and, where necessary, secondary stiffening members are to be arranged.

5.1.7 Pod unit structure scantling requirements are shown in Table 4.5.1. Where the scantling requirements in Table 4.5.1 ~~are not~~ cannot be satisfied, direct calculations carried out in accordance with ~~Section~~ 5.3 may be considered.

5.1.9 The structural response under the most onerous combination of loads is not to exceed the normal operational requirements of the propulsion or steering system components.

5.1.10 For cast pod structures, the elongation of the material on a gauge length of 5.65 $\sqrt{S_o}$ is to be not less than 12 per cent where S_o is the actual cross sectional area of the test piece.

5.1.11 In castings, sudden changes of section or possible constriction to the flow of metal during casting are to be avoided. All fillets are to have adequate radii which should, in general, be not less than 75 mm.

5.1.12 Castings are to comply with the requirements of Chapter 4 or Chapter 7 of the Rules for Materials.

Table 4.5.1 Podded propulsion unit - fabricated structure ~~structural~~ requirements

Table 4.5.2 Direct calculation maximum permissible stresses for steel fabricated structures

5.3 Direct calculations

5.3.6 For cast structures, the localised von Mises stress should not exceed 0,6 times the nominal 0.2 per cent proof or yield stress of the material for the most onerous design condition.

■ *Section 6* Machinery design and construction requirements

6.1 General

6.1.2 Means are to be provided whereby normal operation of the podded propulsion system can be sustained or readily restored if one of the supporting auxiliaries becomes inoperative. *See also* 2.1.1. Consideration shall be given to the malfunctioning of:

- sources of lubricating oil pressure,
- sources of cooling,
- hydraulic, pneumatic or electrical means for control of the podded propulsor.

6.3 Propulsion shafting

6.3.11 ~~On multi-podded ships,~~ In multi-podded propulsor systems or ships having at least one pod in association with other propulsion devices and where the individual pod installed power is greater than 5MW, means are to be provided to hold the propeller ~~on~~ for an inoperable unit stationary whilst the other pod(s) propel the vessel at a manoeuvring speed of not less than 7 knots. Operating instructions displayed at the holding mechanism's operating position are to include a direction to inform the bridge of any limitation in ships speed required as a result of the holding mechanism being activated.

6.5 Bearing lubrication system

6.5.1 The bearing lubrication system is to be arranged to provide a sufficient quantity of ~~lubricating oil~~ lubricant of a quality, viscosity and temperature acceptable to the bearing manufacturer under all ship operating conditions.

6.5.3 For systems employing forced lubrication, ~~T~~ the sampling points required by Pt 7, Ch 3,8.9.6 are to be located such that the sample taken is representative of the oil present at the bearing.

6.5.4 For lubricating oil systems employing gravity feed, the arrangements are to be such as to permit oil sampling and oil changes in accordance with the manufacturer's instructions for the safe and reliable operation of the propulsion system.

Existing paragraphs 6.5.4 to 6.5.7 are to be renumbered 6.5.5 to 6.5.8

~~6.5.5~~ 6.5.6 Where bearings are grease lubricated, means are to be provided for collecting waste grease to enable analysis for particulates and water. The arrangements for collecting waste grease are to be in accordance with the pod manufacturer's recommendations. Alternative arrangements which demonstrate that bearings are satisfactorily lubricated will be considered.

6.8 Pod drainage requirements

6.8.2 Where the design of a pod space has a requirement to be maintained in a dry condition, ~~T~~ two independent means of drainage are to be provided so that liquid leakage may be removed from the pod unit at all design angles of heel and trim, *see* Pt 1, Ch 2,4.6.

■ *Section 8*
Control engineering arrangements

8.1 General

8.1.8 For electronic control systems and electrical actuating systems, the quality plan for sourcing, design, installation and testing of components is to address the following issues:

(a) Standard(s) applied.
(b) Details of the quality control system applied during manufacture and testing.
(c) Details of type approval, type testing or approved type status assigned to the equipment.
(d) Details of installation and testing recommendations for the equipment.
(e) Details of any local and/or remote diagnostic arrangements where assessment and alteration of control parameters can be made which can affect the operation of the podded propulsor unit.
(f) Details of arrangements for software upgrades.

8.1.9 The system integration plan is required to identify the process for verification of the functional outputs from the electronic control systems with particular reference to system integrity, consistency, security against unauthorised changes to software and maintaining the outputs within acceptable tolerances of stated performance for safe and reliable operation of the podded propulsor unit.

8.1.10 For the permitted range of operating conditions, the control system is to be capable of protecting the podded propulsor from experiencing mechanical loads that may initiate damage while permitting the desired manoeuvres to take place.

8.2 Monitoring and alarms

8.2.4 Pod unit ~~bilge~~ dry space pumping arrangements are to function automatically in the event of a high liquid level being detected in the pod unit.

8.2.5 Spaces intended to be dry are to be provided with arrangements to indicate water ingress in accordance with 8.2.6 and Table 4.8.1.

~~8.2.5~~ 8.2.6 The number and location of ~~bilge~~ dry space level detectors are to be such that accumulation of liquids will be detected at all design angles of heel and trim.

Existing paragraph 8.2.6 is to bre renumbered 8.2.7.

Table 4.8.1 Specific alarms for pod control systems

Item	Alarm	Note
Podded drive azimuth angle	—	Indicator, *see* 8.1.4
Propulsion motors	Overload, power failure	To be indicated on the navigating bridge
Hydraulic oil system pressure	Low	To be indicated on the navigating bridge
Bearing temperature	High	For grease lubricated bearings
Motor temperature	High	*See* Vol 2, Pt 10, Ch 1,5.1.3
Lubricating oil supply pressure	Low	If separate forced lubrication for shaft bearings; to be indicated on the navigating bridge
Lubricating oil temperature	High	
Lubricating oil tank level for motor bearings	Low	
Water in lubricating oil for motor bearings	High	Required for single podded propulsion units only
Motor cooling air inlet temperature	High	
Motor cooling air outlet temperature	High	
Motor cooling air flow	Low	
Shaft bearing vibration monitoring	High	*See* 6.3.~~8~~ 10. Monitoring is to allow bearing condition to be gauged using trend analysis
~~Bilge~~ Dry space water pump operation	Abnormal	Alarm set to indicate a frequency or duration exceeding that which would normally be expected
~~Bilge~~ Dry space water level	High	

Volume 2, Part 5, Chapter 1
Torsional Vibration

Effective date 1 January 2009

■ *Section 2*
Details to be submitted

2.1 Particulars to be submitted

2.1.3 Enginebuilder's harmonic torque data used in the torsional vibration calculations, *see* 2.2.3.

Existing paragraphs 2.1.3 to 2.1.6 to be re-numbered 2.1.4 to 2.1.7.

Volume 2, Part 5, Chapter 3
Lateral Vibration

Effective date 1 January 2009

■ *Section 2*
Details to be submitted

2.2 Calculations

2.2.2 The calculated natural frequencies of the system are to be compared to both the shaft rotational orders and propeller blade passing frequencies. Where cardan shafts are fitted, the shaft second rotational orders are also to be considered.

2.2.3 Requirements for calculations may be waived upon request provided evidence of satisfactory service experience of similar dynamic installations is submitted.

Volume 2, Part 5, Chapter 4
Shaft Alignment

Effective date 1 January 2009

■ *Section 1*
General requirements

1.2 Basic requirements

1.2.2 ~~The Builder is to carry out shaft alignment calculations for all installations and to prepare alignment procedures detailing the proposed alignment method and the alignment checks to demonstrate compliance with requirements of this Section.~~ Shaft alignment calculations are to be carried out for main propulsion shafting rotating at propeller speed, including the crankshaft of direct drive systems or the final reduction gear wheel on geared installations. The Builder is to make available shaft alignment procedures detailing the proposed alignment method and checks for these arrangements.

1.3 Resilient mountings

1.3.1 For resilient mountings, *see* Pt 1, Ch 2,5.4.

1.4 Flexible couplings

1.4.1 Where the shafting system incorporates flexible couplings, the effects of such couplings on the various modes of vibration are to be considered, *see* Chapters 2, 3 and 4.

■ *Section 2*
Details to be submitted

2.1 Particulars to be submitted for approval – Shaft alignment calculations

2.1.1 Shaft alignment calculations are to be submitted to ~~Lloyd's Register (hereinafter referred to as 'LR')~~ LR for approval for the following shafting systems~~ where the screwshaft has a diameter of 250 mm or greater in way of the aftermost sterntube bearing~~:

(a) All geared installations, where the screwshaft has a diameter of 300 mm or greater in way of the aftmost bearing.

(b) ~~Installations with one bearing, or less, inboard of the forward sterntube bearing/seal.~~ All direct drive installations which incorporate 3 or fewer bearings supporting the intermediate and screwshaft aft of the prime mover.

(c) Where prime movers or shaftline bearings are installed on resilient mountings.

(d) All systems where the screwshaft has a diameter of 800 mm or greater in way of the aftmost bearing.

2.2 ~~Particulars to be submitted for review –~~ Shaft alignment procedure

(Part only shown)

2.2.1 A shaft alignment procedure is to be ~~submitted~~ made available for review and for the information of the attending surveyors for all main propulsion installations detailing, as a minimum~~, the~~:

~~2.5 Flexible couplings~~

~~*2.5.1* Where the shafting system incorporates flexible couplings, the effects of such couplings on the various modes of vibration are to be considered, *see* Chapters 1, 2 and 3.~~

Volume 2, Part 7, Chapter 1
Piping Design Requirements

Effective date 1 January 2009

Section 5 Pipe connections

5.1 General

5.1.8 For details of non-destructive tests on piping systems, other than hydraulic tests, *see* ~~Pt 1, Ch 3~~ Chapter 13 of the Rules for Materials.

5.4 Welded-on flanges, butt welded joints and fabricated branch pieces

5.4.2 Butt welded joints are generally to be of the full penetration type and are to meet the requirements of ~~Pt 1, Ch 3~~ Chapter 13 of the Rules for Materials.

5.10 Mechanical connections for piping

5.10.12 Restrained slip-on joints are permitted in steam pipes with a design pressure of 10 Bar or less on the weather decks of oil and chemical tankers to accommodate axial pipe movement, *see* Ch 2,2.7.

(Part only shown)
Table 1.5.3 Application of mechanical joints

Systems	Kind of connections
	Slip-on Joints
Miscellaneous	
Starting/Control air (1)	—
Service air (non-essential)	+
Brine	+
CO_2 system	—
Steam	~~–7~~ +7

Section 13 Flexible hoses

13.2 Applications

13.2.3 Rubber ~~or plastics~~ hoses, with single or double closely woven integral wire braid or other suitable material reinforcement, or convoluted metal pipes with wire braid protection, may be used in bilge, ballast, compressed air, fresh water, sea-water, fuel oil, lubricating oil, Class III steam hydraulic and thermal oil systems. Flexible hoses of plastics materials for the same purposes, such as Teflon or Nylon, which are unable to be reinforced by incorporating closely woven integral wire braid are to have suitable material reinforcement as far as practicable. Where rubber or plastics hoses are used for oil fuel supply to burners, the hoses are to have external wire braid protection in addition to the integral wire braid. Flexible hoses for use in steam systems are to be of metallic construction.

Section 16 Testing

16.1 Hydraulic tests before installation on board

16.1.3 Where testing of systems or sub-systems following final assembly is specified, in addition to the requirements of 16.1.2 the lowest applicable pressure as defined in this sub-Section is to be used for testing.

Existing paragraphs 16.1.3 to 16.1.5 are to be re-numbered 16.1.4 to 16.1.6.

~~*16.1.6*~~ *16.1.7* ~~All valve bodies are to be tested by hydraulic pressure to 1,5 times the nominal pressure rating at ambient temperature. However, the test pressure need not be more than 70 bar above the design pressure specified for the design temperature.~~ Valves and fittings non-integral with the piping system, intended for Classes I and II, are to be tested in accordance with recognised standards, but to not less than 1,5 times the design pressure. Where design features are such that modifications to the test requirements are necessary, alternative proposals for hydraulic tests are to be submitted for special consideration.

16.1.8 For requirements relating to valves and cocks intended to be fitted on the ship's side below the load water line, *see* Pt 7, Ch 2,2.5.10.

Existing paragraph 16.1.7 is to be re-numbered 16.1.9.

Volume 2, Part 7, Chapter 3

Machinery Piping Systems

Effective date 1 January 2009

■ *Section 2*
Oil fuel – General requirements

2.1 Flash point

2.1.5 Tanks containing oil fuel are to be separated from vehicle spaces, crew, embarked personnel, passenger and baggage compartments by either:

- a cofferdam formed by a gastight steel division additional to the division which retains the oil, and which is suitably ventilated and drained, or
- a division of all-welded steel construction, designed and tested to withstand a head of water at least 1.5 metres greater than the maximum service head.

Volume 2, Part 8, Chapter 1

Steam Raising Plant and Associated Pressure Vessels

Effective date 1 January 2009

■ *Section 1*
General requirements

1.5 Classification of fusion welded pressure vessels

1.5.6 ~~Heat treatment, non-destructive examinations and routine tests, where required, for the three classes of fusion welded pressure vessels are indicated in Table 1.1.1. Details are given in Pt 1, Ch 3.~~ Details of heat treatment, non-destructive examination and routine tests (where required) are given in Chapter 13 of the Rules for Materials.

1.5.7 Hydraulic testing is required for pressure vessels of Class 1, 2/1 and 2/2.

~~**Table 1.1.1 Heat treatment, non-destructive examination and testing requirements**~~

Class	Radiographic examination	Heat treatment	Routine weld tests	Hydraulic test
1	Required *see* Pt 1, Ch3	*see* Pt 1, Ch3	Required	Required
2/1	Spot required *see* Pt 1, Ch3	*see* Pt 1, Ch3	Required	Required
2/2	—	*see* Pt 1, Ch3	Required	Required

Section 15
Mountings and fittings for cylindrical and vertical boilers, steam generators, pressurised thermal liquid and pressurised hot water heaters

15.2 Safety valves

15.2.9 Safety valves for shell type exhaust gas steaming economisers are to incorporate fail safe features which will ensure operation of the valve even with solid matter deposits on the valve and guide, or features that will prevent the accumulation of solid matter in way of the valve and in the clearance between the valve spindle and guide. Alternatively, if the fitted valves do not incorporate the features described then a bursting disc discharging to a suitable waste steam pipe is to be fitted in addition to the valves. These ~~emergency devices~~ bursting discs are to function at a pressure not exceeding ~~1,5~~ 1,25 times the economiser approved design pressure and are to have sufficient capacity to prevent damage to the economiser when operating at its design heat input level. ~~Full particulars of the proposed arrangements are to be submitted for consideration.~~

15.2.10 To avoid the accumulation of solid matter deposits on the outlet side of safety valves and bursting discs, the discharge pipes and safety valve/bursting disc housings are to be fitted with drainage arrangements from the lowest part, directed with continuous fall to a position clear of the economiser where it will not pose a threat to either personnel or machinery. No valves or cocks are to be fitted in the drainage arrangements.

15.2.11 Full particulars of the proposed arrangements are to be submitted for consideration.

Existing paragraphs 15.2.10 to 15.2.13 are re-numbered 15.2.12 to 15.2.15.

15.12 Additional requirements for shell type exhaust gas steaming economisers

15.12.1 The design and construction of shell type economisers are to pay particular attention to the welding, heat treatment and inspection arrangements at the tube plate connection to the shell.

15.12.2 Every shell type economiser is to be provided with removable lagging at the circumference of the tube end plates to enable ultrasonic examination of the tube plate to shell connection.

15.12.3 Every economiser is to be provided with arrangements for pre-heating and de-aeration, and addition of water treatment or combination thereof, to control the quality of feed water to within the manufacturer's recommendations.

15.12.4 The manufacturer is to provide operating instructions for each economiser which is to include reference to:
- Feed water treatment and sampling arrangements.
- Operating temperatures - exhaust gas and feed water temperatures.
- Operating pressure.
- Inspection and cleaning procedures.
- Records of maintenance and inspection.
- The need to maintain adequate water flow through the economiser under all operating conditions.
- Periodical operational checks of the safety devices to be carried out by the operating personnel and to be documented accordingly.
- Procedures for using the exhaust gas economiser in the dry condition.
- Procedures for maintenance and overhaul of safety valves.
- Emergency operating procedures.

Volume 2, Part 8, Chapter 2
Other Pressure Vessels

Effective date 1 January 2009

Section 1
General requirements

1.5 Classification of fusion welded pressure vessels

1.5.7 ~~Heat treatment, non-destructive and routine tests where required, for the four Classes of fusion welded pressure vessel are indicated in Table 2.1.1. Details of these requirements are given in Pt 1, Ch 3.~~ Details of heat treatment, non-destructive examination and routine tests (where required) are given in Chapter 13 of the Rules for Materials.

1.5.8 Hydraulic testing is required for all classes of pressure vessels.

Existing paragraphs 1.5.8 is to be renumbered 1.5.9.

~~**Table 2.1.1 Heat treatment, non-destructive examinations and testing requirements**~~

Class	Radiographic examination	Heat treatment	Routine weld tests	Hydraulic test
1	Required *see* Pt 1, Ch 3	*see* Pt 1, Ch 3	Required	Required
2/1	Spot required *see* Pt 1, Ch 3	*see* Pt 1, Ch 3	Required	Required
2/2	—	*see* Pt 1, Ch 3	Required	Required
~~3~~				~~Required~~

Volume 2, Part 9, Chapter 1

Control Engineering Systems

Effective date 1 January 2009

■ *Section 1*
General engineering systems

1.2 Plans and information

1.2.5 **Programmable electronic systems.** (In addition to the documentation required by 1.2.2.)

- System requirements specification.
- Details of the hardware configuration in the form of a system block diagram, including input/output schedules.
- Details of power supply and data storage arrangements, *see* 2.9.9 and 2.11.6.
- Hardware certification details, *see* 2.9.5 and 2.11.3.
- Software quality plans, including applicable procedures, *see* 2.9.21.
- Factory acceptance, integration, harbour and sea trial test schedules for hardware and software.
- System integration plan, *see* 2.12.2.
- Failure Mode and Effects Analysis (FMEA), *see* 2.12.5.

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1.2.9 **Cables.** For details of instrumentation and control requirements, *see* Pt 10, Ch ~~2,10~~ 1,10.

Effective date 1 January 2009

■ *Section 2*
Essential features for control, alarm and safety systems

2.9 Programmable electronic systems – General requirements

2.9.8 Means are to be provided to recover or replace data required for safe and effective system operation lost as a result of component failure. The submission required by 1.2.5 is to address reinstatement of system operation following data loss.

~~*2.9.8*~~ *2.9.9* System configuration, programs and data are to be protected against loss or corruption in the event of failure of any power supply. Wherever practical, safe and effective system operation is not to rely on data stored in volatile memory. For Mobility category and safety critical systems, *see* 2.11.6.

2.9.10 Where it is necessary to store data required for system operation in volatile memory, a back-up power supply is to be provided that prevents data loss in the event of loss of the normal power supply. The submission required by 1.2.5 is to include details of any routine maintenance necessary and the measures necessary to restore system operation in the event of data loss as a result of power supply failure.

2.9.11 Back-up power supplies required by 2.9.10 are to be rated to supply the connected load for a defined period of time that allows sufficient time for the re-instatement of supply in the event of loss of the normal power supply as a result of failure of a main source of electrical power. This period is in any case to be not less than 30 minutes.

2.9.12 Where regular battery replacement is required to maintain the availability of volatile memory back-up power supply required by 2.9.10, these are to be included in the schedule of batteries required by Pt 10, Ch 1,1.12.2 and Ch 1,11.7, irrespective of battery type and size. Applicable entries in this schedule are to note that these batteries are not for safety critical systems or essential or emergency services.

Existing paragraphs 2.9.9 to 2.9.21 are to be re-numbered 2.9.13 to 2.9.25.

2.11 Programmable electronic systems – Additional requirements for Mobility category and safety critical systems

2.11.6 Volatile memory is not to be used to store data required to:

- provide a Mobility category system or safety critical function; or
- ensure safety or prevent damage, including during start-up or re-start.

Alternative proposals that demonstrate an equivalent level of system integrity will be achieved may be submitted for consideration.

Existing paragraphs 2.11.6 to 2.11.9 are to be re-numbered 2.11.7 to 2.11.10.

■ *Section 6* Trials

6.1 General

6.1.3 Acceptance tests and trials for Programmable Electronic Systems are to include verification of software lifecycle activities appropriate to the stage in the system's lifecycle at the time of system examination. The documentation required by 1.2.5 is to be in accordance with the current configuration and the testing and trials are to address software modifications to the Surveyor's satisfaction.

Volume 2, Part 10, Chapter 1

Electrical Engineering

Effective date 1 January 2009

■ *Section 3* Emergency and alternative sources of electrical power

3.2 Emergency source of electrical power

~~*3.2.3* The location of the emergency source of electrical power and associated transforming equipment, if any, the transitional source of emergency power, the emergency switch board and the emergency lighting switchboard in relation to the main source of electrical power, associated transforming equipment, if any, and the main switchboard are to be such as to ensure that a fire or other casualty in the space containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard, or in any machinery space of Category A will not interfere with the supply, control and distribution of emergency electrical power. The space containing the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency electrical power and the emergency switchboard is not to be contiguous to the boundaries of machinery spaces of Category A or those spaces containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard. Where this is not practicable, details of the proposed arrangements are to be submitted.~~

3.2.3 The location of:

- the emergency source of electrical power and associated transforming equipment, if any;
- the transitional source of emergency power;
- the emergency switchboard; and
- the emergency lighting switchboard;

in relation to:

- the main source of electrical power, associated transforming equipment, if any; and
- the main switchboard;

is to be such as to ensure that a fire or other casualty in spaces containing:

- the main source of electrical power, associated transforming equipment, if any, and the main switchboard; or
- in any machinery space of Category A;

will not interfere with the supply, control and distribution of emergency electrical power.

3.2.4 The space containing:

- the emergency source of electrical power, associated transforming equipment, if any;
- the transitional source of emergency electrical power; and
- the emergency switchboard;

is not to be contiguous to the boundaries of machinery spaces of Category A or those spaces containing:

- the main source of electrical power, associated transforming equipment, if any; or
- the main switchboard.

3.2.5 Where compliance with 3.2.3 or 3.2.4 is not practicable, details of the proposed arrangements are to be submitted.

Existing paragraph 3.2.4 is to be renumbered 3.2.6.

(Part only shown)

~~3.2.5~~ 3.2.7 The electrical power available is to be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously. The emergency source of electrical power is to be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the following services for the periods specified hereinafter, if they depend upon an electrical source for their operation:

(e) For a period of 18 hours:
  - (i) the emergency fire pump if dependent upon the emergency ~~generator for its~~ source of electrical power~~.~~ ;
  - (ii) the automatic sprinkler pump, if any; and
  - (iii) if any, the emergency bilge pump and all the equipment essential for the operation of electrically-powered remote controlled bilge valves.

(g) For a period of half an hour:
  - (i) any watertight doors if electrically-operated together with their control, indication and alarm circuits;
  - (ii) the emergency arrangements to bring the lift cars to deck level for the escape of persons. Personnel lift cars may be brought to deck level sequentially in an emergency.

Existing paragraphs (g) and (h) to be renumbered (h) and (j).

Existing paragraph 3.2.6 is to be renumbered 3.2.8.

~~3.2.7~~ 3.2.9 The transitional source of emergency electrical power where required by ~~3.2.6~~ 3.2.8 is to consist of an accumulator battery suitably located for use in an emergency which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage and be of sufficient capacity and is to be so arranged as to supply automatically in the event of failure of either the main or the emergency source of electrical power ~~for half an hour~~ at least the following services if they depend upon an electrical source for their operation:

(a) for half an hour
  - (i) the lighting required by ~~3.2.5~~ 3.2.7 (a), (b) and (c). For this transitional phase, the required emergency electric lighting, in respect of the machinery space and accommodation and service spaces may be provided by permanently fixed, individual, automatically charged, relay operated accumulator lamps; and
  - ~~(b)~~ (ii) all services required by ~~3.2.5~~ 3.2.7 (d)(i), (iii) and (iv) unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.

(b) Power to operate the watertight doors at least three times, i.e. closed-open-closed against an adverse list of 15°, but not necessarily all of them simultaneously, together with their control, indication and alarm circuits as required by 3.2.5(g)(i).

Existing paragraphs 3.2.8 to 3.2.13 are to be renumbered 3.2.10 to 3.2.15.

■ *Section 5*
Supply and distribution

5.3 Isolation and switching

(Part only shown)

5.3.2

(b) withstanding, without damage, the overcurrents which may arise during overloads and short circuit. In addition, these requirements do not preclude the provision of single pole control switches in final sub-circuits, for example light switches.

For circuit breakers, *see* 6.5 and 7.3.

■ *Section 6*
System design – Protection

6.1 General

6.1.3 The protection of circuits is to be such that a fault in a circuit does not cause the interruption of supplies used to provide emergency or essential services other than those dependent on the circuit where the fault occurred. For circuits used to provide essential services which need not necessarily be in continuous operation to maintain propulsion and steering but which are necessary for maintaining the vessel's safety, arrangements that ensure that a fault in a circuit does not cause the sustained interruption of supply to healthy circuits may be accepted. Such arrangements are to ensure the supply to healthy circuits is automatically re-established in sufficient time after a fault in a circuit.

Existing paragraphs 6.1.3 to 6.1.9 are to be renumbered 6.1.4 to 6.1.10

6.5 Circuit-breakers

(Part only shown)

6.5.1 Circuit-breakers for alternating current systems are to satisfy the following conditions:

(a) the r.m.s. symmetrical breaking current for which the device is rated is to be not less than the r.m.s. value of the a.c. component of the prospective fault current, at the instant of contact separation (i.e. first half cycle, or time of interruption where an intentional time delay is provided to ensure suitability) ;

6.5.4 Circuit-breakers selection is, and ratings are, to be in accordance with the relevant requirements of IEC 60092-202: *Electrical installations in ships – System design – Protection*. Alternative methods acceptable to LR of selecting suitable circuit-breakers may be considered.

■ *Section 7* Switchgear and control gear assemblies

7.1 General requirements

(Part only shown)

7.1.1 Switchgear and control gear assemblies and their components are to comply with one of the following standards amended where necessary for ambient temperature and other environmental conditions:

(b) ~~IEC 60298: AC Metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 72.5 kV~~ IEC 62271-200: *AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*;

7.3 Circuit-breakers

7.3.2 Circuit-breakers are to be capable of isolation.

Existing paragraphs 7.3.2 and 7.3.3 are to be renumbered 7.3.3 and 7.3.4.

7.16 Position of switchboards

7.16.5 For switchgear and control gear assemblies, for rated voltages above 1 kV, arrangements are to be made to protect personnel in the event of gases or vapours escaping under pressure as the result of arcing due to an internal fault. Where personnel may be in the vicinity of the equipment when it is energised, this may be achieved by an assembly that has been tested in accordance with Annex A of IEC 62271- 200 and qualified for classification **IAC** (internal arc classification).

7.18 Testing

7.18.5 For switchgear and control gear assemblies, for rated voltages above 1 kV, type tests are to be carried out, in accordance with ~~an appropriate standard~~ Annex A of IEC 62271-200 and **IAC** (internal arc classification) assigned, to verify that the assembly will withstand the effects of an internal arc occurring within the enclosure at a prospective fault level equal to, or in excess of, that of the installation.

■ *Section 8* Rotating machines

8.4 Generator control

8.4.5 Generators and their voltage regulation systems are to be capable of maintaining, without damage, under steady state short circuit conditions a current of at least three times the full load rated current for a duration of at least two seconds or where precise data is available for the duration of any ~~longer~~ time delay which may be provided by a tripping device for discrimination purposes. The generator terminal voltage is not to exceed 120 per cent of the rated voltage when the short circuit is removed.

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■ *Section 9* Converter equipment

9.2 Semiconductor equipment

9.2.15 Transformers, reactors, capacitors and other circuit devices associated with ~~convertor~~ converter equipment, or associated filters, are to be suitable for the distorted voltage and current waveforms to which they may be subjected and filter circuits are to be provided with facilities to ensure that their capacitors are discharged before the circuits are energised.

Effective date 1 January 2009

■ *Section 10* Electric cables and busbar trunking systems (busways)

10.5 Construction

10.5.1 Electric cables are to be at least of a flame-retardant, low smoke, halogen free type. Compliance with IEC 60332-1-2: *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1kW pre-mixed flame*, IEC 61034: *Measurements of smoke density of electric cables burning under defined conditions*, IEC 60754: *Tests on gases evolved during combustion of materials from cables* will be acceptable. Where cables are installed in bunches, the requirements of 10.8.8 are to be satisfied. Alternative proposals for equipment cabling that demonstrate satisfactory smoke and toxicity performance under fire conditions for identified areas of a ship may be submitted for consideration where requested by the Naval Authority.

Table 1.10.6 Minimum internal radii of bends in cables for fixed wiring

Cable construction: Insulation	Cable construction: Outer covering	Overall diameter of cable	Minimum internal radius of bend (times overall diameter of cable)
Thermoplastic and elastomeric 600/1000 V and below	Metal sheathed Armoured and braided	Any	6*D*
	Other finishes	≤ 25 mm > 25 mm	4*D* 6*D*
Mineral	Hard metal sheathed	Any	6*D*
Thermoplastic and elastomeric above 600/1000 V – single core	Any	Any	~~20*D*~~ 12*D*
– multicore	Any	Any	~~15*D*~~ 9*D*

10.6 Conductor size

10.6.3 The cable current ratings given in Tables 1.10.3 and 1.10.4 are based on the maximum rated conductor temperatures given in Table 1.10.2. When cable sizes are selected on the basis of precise evaluation of current rating based upon experimental and calculated data, details are to be submitted for consideration. Alternative short circuit temperature limits, other than those given in Table 1.10.4, may be ~~calculated~~ applied using the ~~method~~ data provided in:

- IEC 60724, ~~*Guide to the short circuit temperature limits of electric cables*~~ *Short-circuit temperature limits of electric cables with rated voltages of 1kV (Um=1,2kV) and 3kV (Um=3,6kV)*;or ~~an~~
- IEC 60986: *Short-circuit temperature limits of electric cables with rated voltages from 6kV (Um=7,2kV) and up to 30kV (Um=36kV)*.

Alternative short-circuit temperature limits provided in an acceptable and relevant National Standard Standard may also be considered.

10.8 Installation of electric cables

10.8.2 Bends in fixed electric cable runs are to be in accordance with the cable manufacturer's recommendations. The minimum internal radius of bend for the installation of fixed electric cables is to be chosen according to the construction and size of the cable and is not to be less than the values given in Table 1.10.6.

■ *Section 11* Batteries

11.3 Location

11.3.10 A permanent notice is to be prominently displayed adjacent to battery installations advising personnel that replacement batteries are to be of an equivalent performance type. For valve-regulated sealed batteries, the notice is to advise of the requirement for replacement batteries to be suitable with respect to products of electrolysis and evaporation being allowed to escape from cells to the atmosphere, *see also* 1.4.4.

11.5 Ventilation

11.5.4 Mechanical exhaust ventilation complying with 11.5.9 is to be provided for battery installations connected to a charging device with a total maximum power output of more than 2 kW. Also, to minimise the possibility of oxygen enrichment, compartments and spaces containing batteries with boost charging facilities are to be provided with mechanical exhaust ventilation irrespective of the charging device power output.

11.5.5 The ventilation system for battery compartments and boxes, other than boxes located on open deck or in spaces to which 11.3.2, ~~and~~ 11.3.3 and 11.3.5 refer, is to be separate from other ventilation systems. The exhaust ducting is to be led to a location in the open air, where any gases can be safely diluted, away from possible sources of ignition and openings into spaces where gases may accumulate.

CORRIGENDA

■ *Section 14* Navigation and manoeuvring systems

14.6 Navigational aids

14.6.1 Navigational aids as required by the Naval Authority are to be fed from the emergency source of electrical power. *See also* 3.2.5~~(c)(ii) and 3.3.5~~(d)(ii).

■ *Section 16* Fire safety systems

16.1 Fire detection and alarm systems

16.1.6 The fixed fire detection and fire alarm system are to be capable of remotely and individually identifying each detector and manually operated call point. ~~Indicating units are to denote, as a minimum, the section in which a detector or manually operated call point has operated.~~ At least one indicating unit is to be so located that it is easily accessible to responsible members of the crew. One indicating unit is to be located on the navigating bridge if the control panel is located in the central control station.

16.1.7 Clear information is to be displayed on or adjacent to each indicating unit about the spaces covered and the location of the section and each detector and manually operated call point.

~~*16.1.8* Where the fire detection system does not include means of remotely identifying each detector individually no section covering more than one deck within accommodation, service spaces and control stations is normally to be permitted except a section which covers an enclosed stairway. The number of enclosed spaces in each section are to be limited to the minimum considered necessary in order to avoid delay in identifying the source of fire. In no case are more than fifty spaces permitted in any section.~~

~~*16.1.9* Where the fire detection system does not include means of remotely identifying each detector individually a section of detectors is neither to serve spaces on both sides of the ship nor on more than one deck except when permitted by 16.1.14.~~

16.1.8 Detectors fitted in cabins, when activated, are also to be capable of emitting, or cause to be emitted, an audible alarm within the space where they are located.

Existing paragraphs 16.1.10 to 16.1.15 are to be renumbered 16.1.9 to 6.1.14.

■ *Section 20* Testing and trials

20.2 Trials

(Part only shown)
20.2.4
(g) propulsion equipment is to be tested under working conditions and operated in the presence of the Surveyors and to their satisfaction. The equipment is to have sufficient power for going astern to secure proper control of the ship in all normal circumstances. The ability of the machinery to reverse the direction of thrust of the propeller in sufficient time, under normal manoeuvring conditions, and so bring the ship to rest from maximum ahead service speed, is to be demonstrated at the sea trial, *see also* Pt 1, Ch 2,16.3.7.

Volume 3, Part 1, Chapter 3

Dynamic Position Systems

Effective date 1 January 2009

■ *Section 1* General

1.3 Information and plans required to be submitted

(Part only shown)
1.3.4 Plans of the following together with particulars of ratings in accordance with the relevant Parts of the Rules are to be submitted for:
(a) Prime movers, gearing, shafting, propellers and ~~thrust units~~ thrusters.

(Part only shown)
1.3.5 Plans of control, alarm and safety systems including the following are to be submitted:
(d) Details of the monitoring functions of the controllers, sensors and reference systems together with a description of the monitoring functions.

1.3.6 For assignment of **DP(AA)** or **DP(AAA)** notation, a Failure Mode and Effects Analysis (FMEA) is to be submitted, demonstrating that adequate segregation and redundancy of the machinery, the electrical installation and the control systems have been achieved in order to maintain position in the event of keeping capability in the event of equipment failure (*see* Section 4); or fire or flooding~~,~~ (*see* Section 5). The FMEA is to take a formal and structured approach and is to be performed in accordance with an acceptable and relevant National or International Standard, e.g. IEC 60812.

■ *Section 2* Class notation DP(CM)

2.2 ~~Thrust units~~ Thrusters

2.3 Electrical systems

2.3.3 Where ~~thruster units~~ thrusters are electrically driven, the relevant requirements, including surveys, of Vol 2, Pt 10, Ch 1,15 are to be complied with.

2.3.4 Essential services are those defined in Vol 2, Pt 10, Ch 1,1.5, as applicable, together with thruster auxiliaries, computers, generator and thruster control equipment, reference systems, environmental sensors and electrically driven ~~thruster units~~ thrusters.

2.3.9 On loss of power due to the failure of the operating generator(s) there is to be provision for the automatic starting and connection to the switchboard of a standby set and the automatic sequential restarting of essential services. Consideration may be given to cases where arrangements for automatic re-starting of thrusters would not be practicable. Details are to be submitted in such cases to show that manual means for the immediate re-starting of thrusters would be available at the control station from where the dynamic positioning system would be operated.

2.3.10 Any loads that require an uninterrupted electrical power supply are to be provided with uninterruptible power systems (UPS) having a capacity for a minimum of 30 minutes' operation following loss of the main supply. A UPS is to be provided for each control computer system.

~~*2.3.12* Essential services are to be served by individual feeders. Services that are duplicated are to be supplied from opposite sides of the main switchboard busbar circuit breaker and their cables are to be separated throughout their length as widely as practical and without the use of common feeders, transformers, convertors, protective devices or control panels and circuits.~~

2.3.12 Essential services are to be served by individual circuits. Essential services that are duplicated are:
(a) to be supplied from independent sections of their switchboard or section board;
(b) to have their circuits separated throughout their length as widely as is practicable; and
(c) not to depend upon common feeders, transformers, converters, protective devices, control circuits or control gear assemblies to operate.

2.4 Control stations

(Part only shown)
2.4.3 Indication of the following is to be provided at each station from which it is possible to control the dynamic positioning system:
(e) Availability status of standby ~~thruster units~~ thrusters.

2.4.7 Alarms, in accordance with the requirements of Vol 2, Pt 9, Ch 1,2.3, are to be provided for the following fault conditions as applicable:
(a) When the ship deviates from the area of operation.
(b) When the heading exceeds the allowable deviation.
(c) Position reference system fault (for each reference system).
(d) Heading reference sensor fault.
(e) Vertical reference sensor fault.
(f) Wind sensor fault.
(g) Taut wire excursion limit.
(h) Automatic changeover to a standby position reference system or environmental sensor.
A permanent record of the occurrences of alarms and warnings, and of status changes is to be provided.

■ *Section 3* Class notation DP(AM)

3.1 Requirements

3.1.1 For assignment of **DP(AM)** notation, the applicable requirements of Section 2, together with 3.1.2 to ~~3.1.7~~ 3.1.6 are to be complied with.

~~*3.1.7* In the event of failure of any single thruster, the ship is to be capable of maintaining its area of operation and desired heading in the environmental conditions in which the DP system is intended to operate.~~

■ *Section 4* Class notation DP(AA)

4.1 Requirements

4.1.1 For assignment of **DP(AA)** notation the applicable requirements of Sections 2 and 3, together with 4.1.2 to ~~4.1.9~~ 4.1.10 are to be complied with.

4.1.2 Power, control and thruster systems and other systems necessary for, or which could affect, the correct functioning of the DP system are to be provided and configured such that a fault in any active component or system will not result in a loss of position. This is to be verified by means of a FMEA~~,~~ (*see* 1.3.6) . Such components may include, but are not restricted to, the following:

Prime movers (e.g. auxiliary engines).
Generators and their excitation equipment.
Gearing.
Pumps.
Fans.
Switchgear and control gear, including their assemblies.
Thrusters.
Valves (where power actuated).

Systems which are not part of the DP system but which, in the event of a fault, could affect the correct functioning of the DP system (for example, fire suppression systems, engine ventilation systems, shutdown systems etc.) are to be included in the FMEA.

4.1.4 The electrical generation and distribution arrangements are to be isolatable such that ~~no single fault will result in the loss of more than 50 per cent of the generating capacity or~~ at least the minimum number of any duplicated, or otherwise replicated, items required to provide essential services would remain operational in the event of a single fault. Evidence to verify compliance with this requirement is to be submitted for consideration when required; for example, where it is intended to operate with the independent sections required by 2.3.12 connected together; or where division would be via a single circuit breaker. ~~However, when electrically driven thrusters are employed, a reduction in position keeping capability may be accepted, but this is not to result in a loss of position in the environmental conditions in which the DP system is intended to operate.~~

~~*4.1.5* For electrically driven thruster systems, provision is to be made for the automatic starting, synchronising and load sharing of a non-running generator before the load reaches the alarm level required by 2.3.8.~~

4.1.5 For electrically driven thruster systems:
(a) a reduction in position keeping capability may be accepted, but this is not to result in a loss of position in the environmental conditions in which the DP system is intended to operate; and
(b) provision is to be made for the automatic starting, synchronizing and load sharing of a non-running generator before the load reaches the alarm level required by 2.3.8.

4.1.10 The DP system is to incorporate a computer based consequence analysis to determine whether the position of the vessel would remain within the limits set by the operator in the event of a worst case fault. An audible and visual alarm is to be initiated where the consequence analysis determines that the limits would be exceeded. Where applicable to the timescale for safely terminating operations, the consequence analysis is to allow for manual input of predicted environmental conditions.

■ *Section 7*
Testing

7.1 General

7.1.5 Records and data regarding the performance capability of the dynamic positioning system are to be maintained on board the ship and are to be made available at the time of the Annual Survey. *See* Vol 1, Pt 1, Ch 3,~~2.3.12~~ 2.3.13.

Volume 3, Part 1, Chapter 4
Bridge Navigational Arrangements

Effective date 1 January 2009

■ *Section 1*
General requirements

1.2 Information and plans required to be submitted

(Part only shown)
1.2.1 The following information and plans are to be submitted in triplicate:
- For programmable electronic systems, the plans required by Vol 2, Pt 9, Ch 1,1.2.5.
- Details of the intended area of operation of the ship.

■ *Section 5*
Integrated Bridge Navigation Systems – IBS notation

5.5 Alarm management

5.5.6 Group alarms may be arranged on the bridge to indicate machinery faults, but alarms associated with faults requiring speed or power reduction or the automatic shutdown of propulsion machinery are to be identified by separate group alarms or by individual alarm parameters.

~~*5.5.6*~~ *5.5.7* The following alarms are not to be grouped:
- ~~e~~Emergency alarms;
- Separate group alarms associated with faults requiring speed or power reduction or the automatic shutdown of propulsion machinery;
- ~~s~~Steering gear alarms.

Existing paragraphs 5.5.7 and 5.5.8 are to be renumbered 5.5.8 and 5.5.9.

■ *Section 6*
Trials

6.1 General

6.1.2 For **IBS** Notation, testing at the manufacturer's works and trials on board are to be carried out that cover the individual components and their interaction and the bridge functions and their integration to form the Integrated Bridge System.

Existing paragraph 6.1.2 is to be renumbered 6.1.3.

6.1.4 Acceptance tests and trials for Programmable Electronic Systems are to include verification of software lifecycle activities appropriate to the stage in the system's lifecycle at the time of system examination.

Volume 3, Part 2, Chapter 2

Environemental Protection

Effective date 1 January 2009

■ *Section 2* Environmental Protection (EP) class notation

2.8 Sewage treatment

2.8.8 A suitable piping system from the sewage treatment system or holding tank is to be provided to allow discharge from the system/tank to shore reception facilities. The systems discharge pipe is to terminate with a standard discharge connection complying with the requirements of MARPOL Annex IV, Regulation 10.

Cross-references

Section numbering in brackets reflects any Section renumbering necessitated by any of the Notices that update the current version of the Rules for Naval Ships.

Volume 1, Part 1, Chapter 2

4.5.22	*Reference* to Ch 3,2.3.11 *now reads* 2.3.12.

Volume 1, Part 6, Chapter 6

3.2.2(e)	*Reference* to 3.7 *to be deleted.*
Table 6.3.1	*Reference* to 3.8.15 *now reads* Rules for Materials Ch 13, 2.12.12.
4.3.1(e)	*Reference* to 3.7 *to be deleted.*
4.5.2 ***(4.5.1)***	*Reference* to 4.5.6 *now reads* 4.5.4.
4.5.6 ***(4.5.4)***	*Reference* to 4.5.2 *now reads* 4.5.1.
Table 6.4.1	*Reference* to 4.5.7 *now reads* 4.5.5.
4.8.1	*Reference* to 4.5.2 *now reads* 4.5.1.
4.8.2(o)	*Reference* to 4.5.7 *now reads* 4.5.5.
Table 6.4.5	*Reference* to 4.16.1 *now reads* 4.13.1.
5.3.9	*Reference* to 4.16.1 *now reads* 4.13.1.
5.3.10	*Reference* to 3.8 *to be deleted.*
5.8.3	*Reference* to 3.7.14 *to be deleted.*

Volume 2, Part 2, Chapter 1

9.3.5 ***(9.3.6)***	*Reference* to 9.3.6 *now reads* 9.3.7.
9.3.5 ***(9.3.6)***	*Reference* to 9.3.8 *now reads* 9.3.9.

Volume 2, Part 2, Chapter 3

4.2.7	*Reference* to Pt 1, Ch 3,5.2 *to be deleted.*

Volume 2, Part 4, Chapter 4

6.7.4	*Reference* to 2.2.1(x) *now reads* 2.2.1(w).
10.1.1	*Reference* to 2.2.1(u) *to be deleted.*

Volume 2, Part 8, Chapter 1

15.2.1	*Reference* to 15.2.11 *now reads* 15.2.13.
15.2.7	*Reference* to 15.2.11 *now reads* 15.2.13.
15.3.1	*Reference* to 15.2.11 *now reads* 15.2.13.

Volume 2, Part 9, Chapter 1

2.9.6	*Reference* to 2.11.7 *now reads* 2.11.8.
2.11.1	*Reference* to 2.11.9 *now reads* 2.11.10.
5.2.3	*Reference* to 2.11.7 *now reads* 2.11.8.

Volume 2, Part 10, Chapter 1

3.1.2	*Reference* to 3.2.5 *now reads* 3.2.7.
3.1.3	*Reference* to 3.2.5 *now reads* 3.2.7.
3.1.3(a)	*Reference* to 3.2.5 *now reads* 3.2.7.
3.1.3(c)	*Reference* to 3.2.5 *now reads* 3.2.7.
3.2.7(a)	*Reference* to 3.2.5(a) *now reads* 3.2.7(a).
16.1.3	*Reference* to 16.1.14 *now reads* 16.1.13.

Volume 3, Part 1, Chapter 1

2.7.4	*Reference* to Vol 1, Pt 6, Ch 6,4.10 *now* Vol 1, Pt 6, Ch 6,4.9.

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